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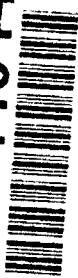
RECONSTITUTION AND DEFENSE CONVERSION

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January 1993

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PREFACE

This paper was prepared under the task "Reconstitution and Defense Conversion" for the Office of the Assistant Secretary of Defense (Production and Logistics). It addresses the implications of reconstitution for the work of the Conversion Commission. The project entailed four subtasks: (i) describe appropriate programs, policies, and industrial capabilities for supporting the reconstitution strategy; (ii) examine available information on reconstitution deficiencies that might emerge during the defense drawdown; (iii) consider appropriate mechanisms for taking special action where needed to preserve specialized capabilities that might be lost during the drawdown; and (iv) consider criteria for determining when special action might be called for.

Valuable comments in formulating this study or in reviews of earlier drafts of this paper were provided by Carl Dahlman, Karen Tyson, Michael Berger, Perkins Pedrick, John Tillson and Philip Major. We thank Teresa Dillard and our editors Eileen Doherty and Shelly Smith for their help in preparing this paper.

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SUMMARY

As the defense budget falls, the base of firms that have supplied DoD will shrink and consolidate. The Defense Conversion Commission was asked to assess how these changes affect DoD's ability to carry out its missions. In the near term, DoD needs a supplier base adequate to support both the employment of current forces and modernization. In the longer-run, the supplier base must be adequate to support *reconstitution*, the focus of this paper.

What is Reconstitution?

Reconstitution is one of four components of the national military strategy.¹ The first three -- nuclear deterrence, forward presence, and crisis response -- meet the challenges of the existing global security environment. Traditional industrial surge and mobilization programs support these elements of the security strategy, particularly the employment of existing forces in crisis response. Reconstitution is intended to ensure that the U.S. could expand its military capabilities more rapidly than could any larger hostile power that might emerge in the future. Given planned levels of U.S. active and reserve forces, intelligence analysts believe there is little risk that the U.S. will need to reconstitute forces in the remainder of this decade.

How Will the Drawdown Affect Our Ability to Reconstitute?

For most U.S. industries that supply defense needs, the defense drawdown is a relatively minor factor in overall business prospects. Even drastic defense cuts will not jeopardize their viability, even if commercial growth does not offset the defense cuts. For example, DoD accounts for about 9 percent of the demand for U.S. metals production. A projected cut of 46 percent in DoD's demands still reduces total industry demand by only about 4 percent.

There are several industries, however, for which DoD's budget cuts will represent a sharp cut in total demand. For one — tanks and ordnance — total demand in 1997 will fall 70 percent from the 1987 peak of the Carter-Reagan defense buildup. In four others —

¹ President George Bush, *National Security Strategy of the United States*, August 1991.

aerospace, shipbuilding, ammunition & chemicals, and electronics — total demand will fall between 16 and 32 percent. In electronics, commercial growth will likely offset the decline in defense demand. In the others, total demand is expected to fall, raising the concern that reconstitution deficiencies might develop. Our review of 131 in-depth studies by defense industrial base experts finds only two specific areas — shipbuilding and aircraft design — where analysts have thus far identified possible reconstitution deficiencies; however, these results are tentative since many of these studies were focused on concerns other than reconstitution.

Still, even an exhaustive review will not support the need for extensive "special actions" to preserve commercial suppliers for the sake of reconstitution. Under current plans, DoD annually will spend at least \$90 billion on research, development, and procurement. These funds will support extensive design, engineering, and production capacity for the most current weapon technologies. They also will pay for Advanced Technology Demonstration programs that can preserve engineering and production teams for systems that may not proceed to full-scale production. (For example, DoD could retain next-generation submarine propulsion teams even if it cancels the current generation program.) Moreover, the U.S. will have a long time to reconstitute — probably 6 to 8 years or more — because a major military buildup by a future adversary would take many years and would be impossible to hide.

What Should DoD Do?

Rather than make extensive investments to retain idle defense-specialized capacity for reconstitution, DoD should position itself so that it can draw on the manufacturing capacity of the entire economy, just as it did when expanding forces in the past. DoD will, of course, always rely on specialized suppliers in certain areas, and reconstitution may require "special actions" to retain some of them. But such actions should be the exception rather than the rule. DoD should place the burden of proof on proponents of special action to show the need for funding. They should be required to show that i) the capability is needed but not funded out of DoD's \$90 billion investment budget, ii) without special action, it is technically infeasible to rebuild a production capability in time to meet a 6 to 8 year reconstitution planning objective, and iii) there are no alternative weapons or tactics that can meet the need.

But to take full advantage of broader U.S. economic potential, DoD faces the challenging task of adapting its weapon designs and administrative practices to make it easier to tap the commercial supplier base for reconstitution. The heart of the reconstitution

strategy is to increase the available pool of suppliers by planning to use innovative force designs, new technologies, advanced design and manufacturing tools and methods, and commercial production capacity. In particular, DoD should:

- Shape active and reserve forces not only to be effective in responding to near-term crises, but also to provide the base for force expansion.
- Make it easier for commercially-oriented firms to deal with the government, and thereby expand the number and capacity of potential DoD suppliers.
- Continue to invest in science and technology, but emphasize i) dual-use technologies and ii) more flexible and commercial-compatible approaches in design and manufacturing.
- Design weapons that reduce the need for defense-specialized production processes.

Removing the barriers between commercial and defense suppliers is essential for reconstitution, and it also supports the near-term goal of assisting conversion from defense to commercial markets. These actions have been recommended by many commissions and study groups over the years. Although they do not require large budgetary changes, they will require fundamental cultural change in the way DoD manages forces and weapons acquisition. The effort will pay substantial returns, however, both in providing insurance against the risk that a new global rival might emerge beyond the turn of the century, and also in improving peacetime efficiency and increasing DoD's access to leading commercial technologies.

RECONSTITUTION AND DEFENSE CONVERSION

A. INTRODUCTION

Defense outlays will fall from their recent high of about 6 percent of the gross national product in 1987 to about 3.5 percent by 1997, leading to substantial realignment and consolidation of the defense supplier base. The Defense Conversion Commission (DCC) is concerned to know how the drawdown of defense budgets will affect this base, and whether deficiencies might develop that jeopardize the ability of the Department of Defense (DoD) to perform its missions. DoD's missions require a supplier base adequate to support the modernization of the active and reserve forces, as well as to support the employment of current forces. In the longer run, the national military strategy requires policies that maintain a healthy industrial base to support *reconstitution* — an expansion of forces to meet emerging threats.

This paper focuses on the long-run reconstitution mission and its implications for the DCC's deliberations. The reconstitution strategy encourages a long-range perspective in viewing defense programs, and therefore provides an important point of view for examining conversion issues. We first describe the programs and policies appropriate for implementing a reconstitution capability. We next outline criteria the DCC can use in assessing the long-run security implications of the drawdown, and review the evidence available on the extent of reconstitution deficiencies that might develop under current program plans. We also consider whether conversion assistance programs might provide an appropriate intervention mechanism to support essential capabilities.¹

¹ This paper addresses two of the tasks of the DCC. The charter states these two tasks as follows: "The Commission shall review (a) the impact on the U.S. economy of the reduction of resources devoted to defense procurement, and (b) the potential for strengthening or establishing Federal programs...for appropriate cooperative ventures between the Federal government and companies predominantly engaged in defense-related activities to assist the companies in converting to predominantly commercial activities." D. J. Atwood, "Defense Conversion Commission," April 14, 1992.

1. Reconstitution and the Commission's Tasks

Reconstitution is one of four components of the national military strategy.² The first three components -- nuclear deterrence, forward presence, and crisis response -- are designed to meet the challenges of the existing global security environment. Reconstitution, in contrast, focuses on the capability to expand forces in response to future threats. Nationalism, and ethnic and religious intolerance remain powerful forces in the world, which could in time spawn an aggressive, anti-western power. An adequate reconstitution capability would ensure that the U.S. could thwart the military ambitions of any such potential rival. Maintaining the commitment and capability to reconstitute also may help cement the nation's role in international cooperative security arrangements, and it may deter other nations from initiating a renewed arms competition in the first place.

The National Security Strategy defines the needed reconstitution capability as follows:

The standard by which we should measure our efforts is the response time that our warning processes would provide us of a return to previous levels of confrontation in Europe or in the world at large. We and our allies must be able to reconstitute a credible defense faster than any potential opponent can generate an overwhelming offense.³

Although it is difficult to imagine precisely why or how a global rival might emerge, a review of the military and industrial *capabilities* of nations around the world provides an appropriate benchmark for judging the adequacy of U.S. reconstitution capabilities. Intelligence analysts now believe that it will be many years before any group of nations could develop military capabilities comparable to those of the U.S. and its allies. Given planned levels of U.S. active and reserve forces, they should be adequate to meet conventional military threats that might realistically be expected to emerge in the remainder of this decade. There is thus a very low probability that the U.S. would need to reconstitute forces within this time frame. Moreover, a major military buildup by a potential opponent would be impossible to hide in today's highly interconnected world, so the time available for reconstitution is expected to be many years — at least five years and probably many more.

There are three reasons why reconstitution capabilities should be of particular concern to the DCC. The first — and most obvious — is that reconstitution is a central

² President George Bush, *National Security Strategy of the United States*, August 1991.

³ *Ibid.*, p. 30.

element of the national military strategy, so it is essential to consider the requirements for supporting reconstitution in assessing the national security implications of drawdown plans.

There is a second, equally compelling reason why the reconstitution strategy is important: it engenders a forward-looking approach to decisionmaking, which is needed for managing ongoing programs as well as for creating a reconstitution capability. Without reconstitution as a pillar of U.S. strategy, the lack of an immediate rival could, for example, lead the Department's science, technology, and development programs to drift toward arcane, specialized weapons designs that would be increasingly difficult to build and field. Inertia also could lead the Department to ignore the doctrinal innovation necessary to use new technologies effectively, or to forestall the management changes needed to reduce its reliance on a shrinking base of specialized weapons producers. The U.S. should take advantage of the current peace to develop the technologies, forces, and management approaches that will ensure military security in the long run. As we shall see, the reconstitution strategy encourages this: at its heart are programs and policies that increase the nation's flexibility to expand military power using innovative force designs, new technologies, and advanced industrial tools and methods.

The creation of a reconstitution capability may require *interventions* and subsidies to retain elements of the existing defense supplier base, but such actions should be the exception rather than the rule. For example, it may be necessary to intervene to retain such highly specialized production capabilities as nuclear submarine propulsion system engineering and production in order to provide a base for future modernization programs or reconstitution. Generally, any such programs and policies designed to preserve existing capabilities should be assessed in terms of their contribution to long-run reconstitution capabilities. Reconstitution thus provides a needed broader perspective for assessing the security implications of the drawdown. Without this perspective, and in the absence of a pressing threat, there will be strong pressure to retain current force levels and to support the existing base of weapons suppliers.⁴

Finally, in providing this longer-range perspective, the reconstitution strategy also suggests criteria for the DCC's evaluation of alternative conversion assistance programs. In what areas will the drawdown cause losses of essential resource base capabilities?

⁴ This tendency has been evident in the political debate on the defense budget. DoD has attempted to cut current generation programs in favor of continuing development of next generation programs; whereas Congress has favored continuation of current programs. See Barry M. Blechman, "The Narrowing Debate on Defense Issues," (Washington, D.C.: Defense Forecasts, Inc., October, 1992), p 12.

Because the reconstitution strategy is forward looking, with an emphasis on flexibility, one of its main goals is to eliminate, over time, DoD's reliance on highly specialized suppliers and production capabilities. Hence, the strategy counterbalances the natural tendency to focus on preserving the base as it exists today, rather than to focus on opportunities for creating new capabilities.

2. Overview

We begin (in Section B) by describing the elements of a reconstitution strategy appropriate for the current global security environment. We show that the appropriate programs and policies to support reconstitution are those that build flexibility into ongoing DoD activities. This includes designing the base force to provide a foundation for possible force expansion, reforming acquisition practices to increase DoD's ability to expand its supplier base, and pursuing a research strategy to increase DoD's flexibility to expand military power. Reconstitution should incorporate the weapons and force concepts that are current at the time reconstitution would be executed, that is, weapons that will be in development or production in the next decade and beyond. At the heart of the strategy are programs and policies that increase the nation's flexibility to expand military power using innovative force designs, new technologies, improved management approaches and advanced industrial tools and methods.

Our analysis (Section C) of the available evidence shows there will be very few areas where lead times are so long that it will not be possible to reestablish design and production capabilities. In terms of specific policy measures, we recommend stringent criteria for intervention to maintain an existing capability. These should hinge on the technical feasibility of recreating a capability quickly enough to meet the 6 to 8 year reconstitution planning objective.

"Lost arts" are most likely to emerge in defense specialized sectors for which gaps in development and production are foreseen. Overall industry trends indicate only one area — tanks and ordnance — where the drawdown might affect the viability of an entire industry. In four other areas — aerospace, shipbuilding, ammunition and chemicals, and electronics — the cut in DoD demands represents between 16 and 32 percent of total industry demands. To assess the available information on possible deficiencies, we reviewed 131 studies of the defense industrial base. Although most of these studies did not focus explicitly on the reconstitution mission, they show the kinds of data and analyses that are available on industrial capabilities. We found two additional areas — shipbuilding and aircraft design — where possible reconstitution deficiencies were identified. We

recommend that these areas be given careful scrutiny in light of the criteria we propose before spending money to preserve existing capabilities.

Section D examines the question, Should the Commission consider targeting conversion assistance programs toward potential "lost arts"? First, we show that Defense Department programs already provide sizable direct investments in the industrial base. DoD could direct these as needed to meet reconstitution requirements. Of course such programs will need to be appropriately targeted and adequately funded if they are to be used to retain reconstitution capabilities. At the same time, we find that "lost arts" are inherently defense-specialized capabilities, so there is no practical way to preserve them through conversion to commercial applications.

Section E summarizes the implications of these analyses for the DCC's deliberations.

B. THE RECONSTITUTION STRATEGY⁵

President Bush introduced the reconstitution concept in his August 1990 speech on the U.S. National Security Strategy for the post-Cold War era. Because the need for a reconstitution capability was first enunciated in general terms, and its strategic rationale has been evolving, many of the details of the concept and its implementation remain to be hammered out.⁶

The strategy presumes that "(w)arning times will be so great that we will have the option to respond by generating wholly new capabilities."⁷ In short, reconstitution would not necessarily entail a traditional mobilization of reserves or an emergency surge of industry production; rather, it entails broad based expansion of forces including the recruitment and training of new people as well as the introduction of a new generation of weapons and force concepts. In this conceptualization, reconstitution is comparable to the

⁵ This section draws upon Herschel Kanter and Richard H. Van Atta, *Integrating the Defense and Civil Technology and Industrial Bases*, IDA P-2801, (Alexandria, Va.: Institute for Defense Analyses, December 1992), and David R. Graham, "Reconstitution," June, 1992.

⁶ Some noteworthy contributors in the effort to define a program for reconstitution include: U.S. Congress, Office of Technology Assessment, *Redesigning Defense: Planning the Transition to the Future U.S. Industrial Base*, OTA-ISC-500, (Washington, D.C.: U.S. Government Printing Office, July, 1991); U.S. Congress, Office of Technology Assessment, *Building Future Security: Strategies for Restructuring the Defense Technology and Industrial Base*, OTA-ISC-530, (Washington, D.C.: U.S. Government Printing Office, June, 1992); Los Alamos National Laboratory, *Reconstitution and the Defense Build-Down: Innovative Concepts and Applications*, (Los Alamos, CA, 1992); and James A Blackwell, "The Defense Industrial Base," *Washington Quarterly*, Vol. 15, No. 4., Autumn 1992, pp. 189-206.

⁷ "The Fourth Pillar," *op. cit.*

defense buildup prior to World War II, and some have described it as akin to repeating "(t)he Reagan buildup in the year 2000."⁸

This view of reconstitution has emerged as the accepted approach in the policy community. It has significant implications for the operational concept for reconstitution preparedness programs and policies. As target response times are relaxed, the potential for tapping national assets through investment and conversion — rather than by subsidizing extensive, in-place reserve production facilities — increases. The operational concept for reconstitution outlined in this paper therefore focuses on meeting objectives not with expensive subsidy programs, but rather by building greater flexibility into DoD's ongoing programs. We suggest a strategy encompassing four broad policy goals:

- Shape active and reserve forces not only to be effective in responding to near-term crises, but also to provide the base for force expansion.
- Make it easier for commercially oriented firms to deal with the government, and thereby expand the number and capacity of potential DoD suppliers.
- Continue to invest in science and technology, but emphasize i) dual-use technologies, and ii) more flexible and commercial-compatible approaches in design and manufacturing.
- Design weapons that reduce the need for defense-specialized production processes.

These elements of the reconstitution strategy can be implemented primarily by shaping the execution of ongoing DoD programs, so their direct budgetary implications are relatively modest. Nevertheless, the changes required are fundamental. Reconstitution requires a cultural change within DoD, which in time would create forces, management processes, technologies, and a supplier base that are *forward-looking*, *flexible*, and *integrated*. DoD's programs need to be *forward-looking*, focusing on the requirements for future systems rather than trying to maintain the capacity to build today's systems. Programs and policies should increase the *flexibility* of the acquisition system to develop, test, and field new or improved weapons concepts. DoD can only afford limited, full-scale production, but must be prepared to shift to large-scale production.

Finally, the most difficult challenge will be to *integrate* broad segments of the defense supplier base within the commercial economy by eliminating technical and administrative barriers to serving DoD markets. There are, of course, limits to the feasible degree of integration, because the markets served by some prime contractors and highly

⁸ *Ibid.*

specialized component suppliers will continue to required dedicated DoD suppliers. For example, DoD will always rely on specialized suppliers for major, high-technology systems such as the F-22 aircraft. But across a broad range of DoD's purchases, the potential exists to reduce the barriers between defense and commercial suppliers.

Integration not only supports reconstitution, it also will give DoD increased access to leading commercial technologies and avoid the high costs of maintaining a specialized supplier base. A recent Office of Technology Assessment survey of defense contractors found that contractors believe such integration could be pursued on a case-by-case basis.⁹ Integration makes sense in certain areas where dual use of technology and manufacturing is feasible, such as in electronics or aerospace production. Integration requires an emphasis on dual-use technologies, and weapon designs that can take advantage of commercial production capabilities. And it requires development and management processes that are more compatible with the commercial world. Integration is essential in today's technology and security environment, but the barriers to achieving it are monumental — it will require a sustained high-level commitment on the part of both the Executive and Legislative branches.

The extent to which these four policy goals can be realized will determine how fast and at what cost an expanded force can be built, and how effective that force will be. Each of these four areas is discussed in turn, and its implications for conversion policies are then delineated.

1. Maintain Active and Reserve Forces that Provide a Reconstitution Base

As a first order of business, any reconstitution strategy must focus on the problems associated with manning and training proficient military units within a reasonable period of time. Although the target for reconstituting forces will undoubtedly evolve, the order of magnitude of the task is suggested by the size of the build up that would be required to reconstitute from the currently proposed 1997 "base force" to 1990 force levels (see Table 1). The magnitude and feasibility of the force expansion will vary across warfare areas, and will depend as well on the how much the force shrinks over the remainder of this decade. Nevertheless, as a rule of thumb it appears that roughly a one-third expansion of active duty manpower is consistent with the currently planned drawdown.

⁹ *Redesigning Defense*, op. cit., p. 90.

Table 1. Reconstitution Force Expansion Targets

	Divisions	Air Wings	Ships	Personnel*
FY 1990	28 (18 active)	36 (24 active)	546	2.1 mil.
Base Force	18 (12 active)	26 (15 active)	451	1.6 mil.
Difference	10	10	95	.5 mil
% Force Expansion to Reconstitute	55%	38%	21%	31%

* Active component

Raw numbers would not prevent reconstitution. The real question is whether there would be sufficient time to create units that are proficient in their roles and missions. In the near term, there may be a satisfactory solution to this problem involving recalls from the pool of retired and separated soldiers, sailors, airmen and officers. They provide an important asset that could be drawn upon for several years into the future, if needed. For the longer term, reconstitution will entail building units with a new generation of officers and enlisted personnel. The Department of Defense needs to address these issues by expanding the scope of its total force policy to incorporate reconstitution considerations. Within this policy, three potential ways to lay the groundwork for reconstitution should be considered: maintaining cadre force units to provide the leadership and structure for reconstitution; designing specialized roles and missions that simplify the tasks of reconstitution units; and incorporating technological advances in individual and unit training and weaponry to accelerate the development of proficient new units.

a. Cadre Units

Currently, the Defense Department plans to maintain cadre force units for reconstitution that include two Army cadre divisions.¹⁰ The Navy also has plans for reconstituting its frigate force, using mothballed FF-1052-class vessels and a core of trained reservists.¹¹ Under this program, an additional 32 ships could be returned to

¹⁰ Richard Cheney, *DoD Annual Report to the President and Congress*, (Washington, D.C.: Department of Defense, 1992), p. 69.

¹¹ *Ibid.*, p. 74.

service within six months. These two programs are good first steps, but a more comprehensive total force policy that includes reconstitution considerations is needed.

Questions that such a policy must address are: How much should be invested in creating a cadre infrastructure for reconstitution units? Should unit designations be retained for all or part of the 10 Army divisions, 10 Air wings, and 95 ships that are in the notional reconstitution plans outlined above? Within these units, to what extent should leadership cadre and unit equipment be retained? How could these investments be put to productive use? One possible answer would be to designate a few cadre units for each Service, and to use these units as test beds for reconstitution concepts. Officers assigned to reconstitution units could be tasked to plan for reconstitution within their Service, and to conduct field experiments with alternative force concepts, doctrine, weapons, and training. Employing reconstitution units as test beds should help retain their vitality and currency, and make them relatively attractive assignments.

b. Roles and Missions

In collaboration with the Services' experimental cadre units, the Service, civilian, and joint military leadership should consider a broad range of alternative force designs and force management policies that could make reconstitution easier. Must reconstitution units replicate the active and reserve forces, or could they be designed to handle more specialized, perhaps less demanding tasks? If force management plans for reconstitution units incorporated a "building block" approach rather than replicating existing units, the time required for unit training might be significantly reduced. This approach would be particularly beneficial if such units could be designed to perform tasks that are relatively self-contained, so that they could be performed competently without extensive large unit training. Advances in command, control, and communications technologies may allow building-block units to be coordinated with the conventional combat arms units with less extensive field training than is required today.

This approach might be applicable to some combat arms functions, such as air defense or artillery units that do not fight shoulder to shoulder with maneuver units. Military operational concepts emphasizing the reconstitution of units such as these would make reconstitution a more tenable element of national strategy.¹² But the concept may be most applicable for support and combat service support functions. Small units competent

¹² For a discussion of the linkages between strategy, operational concepts, and reconstitution, see John Tillson, *Reconstitution Planning for Europe*, IDA P-2675, Institute for Defense Analyses, Alexandria, VA, December 1991.

in skill areas comparable to civilian occupations — such as telecommunications, logistics, or maintenance — could perhaps be created and trained quickly by using people who employ similar skills in their civilian occupations.

c. Standby Agreements for Support Functions

In planning for support functions, DoD should establish standby contracts with firms in industries such as telecommunications, engineering, electronics maintenance, medical support, food processing, catering, laundry, automotive and aircraft maintenance, express delivery, and construction. This approach would expand the concept of the Civil Reserve Air Fleet (CRAF), in which the government contracts with civilian airlines to provide crisis-response services on a contingency basis. In the Desert Shield-Desert Storm Operation, for example, not only did the CRAF system operate well, but there also was an extensive infrastructure of contractor support across a wide spectrum of military functions. The CRAF fleet transported 65 percent of all troops to Saudi Arabia and 25 percent of all airlifted cargo.¹³ In addition, contractors deployed with many weapon systems, including the Patriot missile and the JSTARS aircraft, to provide maintenance, repair, training, and other functions. Many support functions for existing forces, as well as for reconstituted forces, could similarly be provided on a contingency basis under contract to the DoD. These could include telecommunications, logistics, engineering, medical support, catering, laundry, and maintenance and repair. These functions could be provided cost-effectively on a contingency basis in the future — either for a protracted deployment of standing forces or for reconstituted forces. They could be contracted for in advance with first-rate commercial suppliers, through a system of stand-by contingency contracts, essentially as is done under the current CRAF contract.

c. Training

If the nation were to reconstitute forces beyond the turn of the century, a new generation of soldier would have to be trained. Modern warfare — as practiced by the United States military — is a highly integrated, large-scale operation. This kind of warfare requires proficiency both at the level of the individual soldier and at the level of the combat unit. Training new, large-scale units could therefore be the major determinant of the time required to reconstitute forces, conceivably requiring even more time than that required for equipping the reconstituted units.

¹³ Ibid., p. 93. In addition, the Secretary of Defense's Annual Report notes that commercial ships hauled 68 percent of all cargo into the theater (p. 93).

Technology could help with this task in two ways: First, simulation technology for training could reduce both the time required for training and the demands for training personnel. This is an area that presently is receiving a high level of attention from the military Services. Second, technology could be integrated in the next generation of weapons and support systems to make them easier to operate, allowing soldiers to become proficient in their use relatively quickly. The use of Stinger air defense missiles by Afghan peasants in their war against Soviet forces presented a graphic example of how a technically advanced weapon could be used effectively with a minimum of training. In addition to improvements in training, DoD should also consider "lateral entry" personnel policies, which would allow trained civilians in technical specialties, such as maintenance, computers, electronics, and construction, to enter military jobs without extensive basic or advanced military training.¹⁴

In summary, the design of reconstitution force units, weapons, and training will be important determinants of the time required to reconstitute forces. This is an area that deserves much more thought, but, as yet, only the most far-sighted military thinkers have begun to focus on these long-run issues. Creation of a total force policy for active, retired, and reconstitution forces is an essential first step in implementing the reconstitution strategy. The first policy goal for implementing a reconstitution capability is to develop and deploy a base force amenable to reconstitution. It will be necessary to design the active and reserve forces with built-in flexibility for expansion within the 6 to 8 year reconstitution planning horizon. Like earlier national military buildups from small force structures, this base force expansion must draw on the skills and capability of the entire economy.

d. Managing Modernization

A successful transition to a future defense capability that can be flexibly reconstituted requires important tradeoffs among modernization investment, technology investment, hardware procurement, and current readiness. In the future, the DoD requires an acquisition strategy that emphasizes advances in the state of the art without investing in unneeded development and production. Various proposals for combining ongoing design

¹⁴ This option is explored in depth in Karen Tyson and Stanley Horowitz, *Lateral Entry of Military Personnel*, IDA P-2565, Institute for Defense Analyses, Alexandria, VA, March 1992.

efforts with limited production include "virtual swords,"¹⁵ "flexible acquisition,"¹⁶ "rollover-plus,"¹⁷ "prototyping-plus,"¹⁸ and "dual-track prototyping."¹⁹

Each of these approaches emphasizes the use of simulation and other techniques to ensure producibility. In addition, the recent DoD acquisition strategy contains, as one element, an increased emphasis on the use of Advanced Technology Demonstrations (ATDs). ATDs are to be used—

... to conduct more rigorous 'up-front' technology developments so that the acquisition cycle can be made less risky....These ... will range from demonstrating the military utility of new technological concepts in a laboratory environment to integrating and assessing technology in as realistic environment as possible.²⁰

ATDs also could be used to demonstrate the capability to manufacture a missile in a plant meant for another purpose, or to adapt the military system to the plant, or to modify the plant to manufacture the system. Indeed, the current and proposed program of "Technology for Affordability" includes a whole series of demonstrations of manufacturing processes for major system components, mostly involving electronics. This approach could be extended to experiments with whole missiles, or with major subsystems of ships or aircraft, e.g., an aircraft wing or a section of a ship hull. Of course, there will always be some problems that emerge when a system enters production, but these new approaches promise to reduce the problems that traditionally have been encountered when a program enters engineering and manufacturing development. This new approach should thus reduce the time required to bring development programs into production.

¹⁵ "Long Shadows and Virtual Swords: Managing Defense Resources In the Changing Security Environment," Ted Gold and Rich Wagner, April 1990, unpaginated.

¹⁶ *The Future of Military R&D: Towards a Flexible Acquisition Strategy*, Paul H. Richanbach et al., IDA P-2444, Institute for Defense Analyses, Alexandria, VA, July 1990, pp. 15-17.

¹⁷ "Tomorrow's Defense From Today's Industrial Base: Finding the Right Resource Strategy for a New Era," Rep. Les Aspin, Chairman, House Armed Services Committee, February 12, 1992, unpaginated. Rep. Aspin proposes a program of four elements: selective upgrading, selective low-rate production, rollover-plus and silver bullet procurements.

¹⁸ *Building Future Security, Strategies for Restructuring the Defense Technology and Industrial Base*, Office of Technology Assessment, Congress of the United States, Washington, DC, June 1992, pp. 12-13 and 51-75.

¹⁹ See *Holding The Edge: Maintaining the Defense Technology Base*, Office of Technology Assessment, Congress of the United States, Washington, DC, April 1989, pp. 11-13.

²⁰ *Defense Science and Technology Strategy*, op. cit., p. I-16.

In summary, the design and management of DoD forces, support strategies, training, and modernization programs will be key factors determining the nation's capability to reconstitute. Incorporation of reconstitution considerations in ongoing programs is perhaps the most important component of a reconstitution strategy.

2. Tailor Regulation to Remove Procedural Barriers To Defense-Commercial Integration

In the post-World War II era, DoD developed a highly specialized supplier base geared toward meeting its detailed, complex military specifications. In parallel, the DoD acquisition system has evolved to manage the design, development, and production of highly specialized weaponry and equipment. This system became increasingly formal over the years, as the Legislative and Executive branches imposed increasingly stringent regulations on the close customer-buyer relationship between DoD and industry. These regulations govern the contractor and the DoD. Both are open to investigation, oversight and even criminal prosecution, internally and externally, by the General Accounting Office and various committees of Congress.

This approach has evolved primarily with major programs in mind, but it defines the underlying philosophy for all of DoD's acquisitions, even for those products that are commercial, off-the-shelf items. These regulations put extraordinary burdens on DoD's suppliers and raise barriers to commercial firms that might otherwise enter the market. Many of DoD's acquisition regulations are conflicting and counterproductive. More to the point, even when these controls are similar to those enforced in society at large, specialized reporting requirements are called for; even the criminal law is at times introduced into what are otherwise civil matters. Many commercial firms have opted out of the DoD market because of the barriers created by the acquisition system; others find that they must establish separate DoD units. One result of this separation between defense and commercial supplier base is that firms or divisions that work primarily for DoD organize, market, and manage differently than do commercial firms.

When reviewing the defense acquisition process, it becomes apparent that there is much room for narrowing the domain where the extraordinary requirements for regulation and oversight are employed. Tailoring regulation to permit commercial-like processes and procedures for a wider range of transactions would reduce the barriers to dealing with DoD. This also would reduce a barrier to diversification faced by DoD's present suppliers, who cannot both comply with DoD's regulations and compete effectively in commercial markets. Tailored regulation thus makes sense from the standpoint of reducing the costs of

military systems and related subsystems and components, and it would improve the capability to reconstitute forces.

A goal of the reconstitution strategy should be to break down barriers to commercial firms' participation in defense contracting, whenever feasible. The evolution of the specialized defense supplier base has been caused partly by the technological incompatibility between defense and non-defense products, and partly by regulatory barriers to entry. On both fronts, DoD must seek to reduce specialization in order to make headway. With respect to technology, DoD needs to design products that rely less on a specialized supplier base. With respect to regulation, DoD needs a tailored approach that would keep the main elements of DoD regulation for major development programs, but deregulate transactions for the huge number of goods and services that are off-the-shelf, or slightly modified versions of commercial goods.

a. DoD Product and Transaction Types

Tailoring the application of DoD's rules and regulations could increase integration and flexibility without undermining the integrity of the acquisition system.

There are two main ways in which regulations can be tailored. First, in most of its transactions DoD demands proof of what an item costs and a detailed description of its specifications. This approach may be unavoidable for specialized DoD suppliers, but it is foreign to most commercial firms. DoD uses a commercial approach — comparison shopping — for standardized, catalogue items. We propose expanding the application of this approach to a range of DoD's transactions. Many items, such as replacement parts, hand tools, or soldier support items, could be purchased using commercial practices. Even complex items that are customized versions of commercial products, such as trucks, computers, software, or aircraft engines, can be bought using commercial practices. What is needed is a change in focus from measuring the costs of the things DoD buys, to a "market analysis" approach that focuses on price and value.

A second element of the tailored regulation approach is to create market forces whenever possible. Many regulations are intended to limit the monopoly power of specialized suppliers. One alternative is to adopt procurement strategies, where feasible, that threaten the contractor's monopoly power. For instance, DoD should ask: Are there alternative strategies or tactics that would be more efficient than buying a particular hardware item? Are there other weapons or modifications that would be more efficient? These approaches can substitute in many cases for market competition where none would otherwise exist.

The potential for tailoring regulation can be demonstrated by examining the spectrum of transactions DoD engages in. Table 2 summarizes how regulation applies to four classes of products, based on nature of the transaction and the degree of technological and cost uncertainty. These are discussed in turn.

Table 2. Four Product Classes

Class Description	Product Class			
	Major New Development	Modification, Component or Low Risk Development	Customized Version of Standard Product	Generic or Standard Product
Product Characteristics	Development of major new military system	Modification of existing military system, or development of a relatively simple system	Made-to-order products or spare parts with close commercial analogues	Standard commercial product available from catalog or in highly competitive market
Examples	B-2 F-22 Seawolf submarine	M-1 upgrade F-15E upgrade Truck development	Militarized version of commercial vehicle, computer, or clothing Spares Construction	Off-the-shelf computers, light bulbs, standard software, or automobiles
Nature of Market	Bilateral monopoly once contractor selected Unique product Negotiated contracts Cost reimbursement contracts	Bilateral monopoly Product similar to existing product or products Negotiated contract Cost reimbursement or fixed price	Competitive with many suppliers Custom product, but many similar substitutes Competitive Contracts Fixed Price	Competitive Standard Product Competitive Contract Fixed Price
Degree of Uncertainty	Highly uncertain technology, cost, and capability	Moderate uncertainty, but ability to predict based on comparison to similar products	Low uncertainty, with ability to compare and get prices on many similar products	Known, standard product

Developments of Major Systems. Risk and uncertainty are very high in DoD's major systems' R&D and this profoundly affects the weapon acquisition process. These uncertainties preclude the development of a market system and fixed price contracts. Four key features of this non-market system for major design, development, and procurement programs are:

- The government "customer" plays a major role in shaping the product, from its initial concept to its development and production. This has encouraged the evolution of specialized producers whose fate is tightly linked to responding to and shaping the government's needs.
- Once a developer is selected, a bilateral monopoly exists. DoD must deal with a monopoly supplier over the remaining years of the program.²¹
- Few types of any major system are procured at any one time, so only a few contending firms will survive in a system or subsystem area. Attempts over the years to employ special measures to keep a "sufficient number of firms in business in each field of weaponry" have stemmed largely from the desire to get around this inherent tendency toward concentration.²²
- The uncertain costs and technology involved in major development programs prevents the DoD from entering into fixed-price contracts. DoD contracts for systems R&D on a cost-plus-fixed-fee basis, and administrative mechanisms are substituted for market analysis and competition.

In most major programs DoD's leverage drops sharply once a developer is selected. DoD and the contractor must negotiate yearly contracts as bilateral monopolists, where neither has a good alternative to continuing the ongoing business relationship. This has led DoD to exercise considerable oversight as the system is developed and produced. This approach stems from the belief that, without such measures, the public interest would be injured by (1) the high degree of control by individual firms over entire areas of defense systems, and (2) exploitation of a monopoly or near monopoly.

This line of reasoning is compelling — if perhaps overstated — for major development programs; however, for other classes of goods, monopoly power presents

²¹ Peck and Scherer op. cit., p.325.

²² Peck and Scherer, op. cit, pp. 374-376. The authors refer to the "hungry contractor" criterion for selecting contractors, which essentially implies that firms that were already well-positioned in the market were discriminated against in the bid review process. One rationale of this criterion is related to prospective performance — a heavily committed contractor might give a new program inadequate attention. But clearly there are other factors not directly pertinent to the actual contract under bid, but related to sustaining a mix of vendors for future bidding competition and production requirements, that are important.

less of a problem. Applying the regulations designed for major, risky development programs to simpler, less risky transactions is counterproductive, and unduly restricts the base of suppliers that will do business with DoD.

Non-Major and Modification Programs. Programs that are less ambitious than major development programs may still have the problem of dealing with a monopoly seller, but they often involve considerably less technological and cost uncertainty. Moreover, the government often will have more leverage in negotiating with the contractor because good substitutes (e.g., the existing system, another similar type of existing system, or an upgrade of a similar system) will exist, and there will be better cost and pricing data available from the earlier production and/or development experience of the original system. For many transactions within this class, reduced uncertainty will allow the DoD to price such systems using market comparisons, and to enter into fixed price agreements requiring considerably less oversight than the development of a major new system.

Customized Products. Customized versions of commercial products represent another step in the spectrum of product uncertainty. Relative to either of the first two transactions, there is substantially more information available for price and value comparison shopping. In many cases, data will exist for similar products. Competition is likely to exist for most of these products. There may be moderate uncertainty, but the DoD will still be able to make comparisons and establish reasonable prices using market comparisons. When fixed price contracts are established, there should be relatively little need to oversee the management of such suppliers. Yet this class of transaction, which includes items ranging from components and spare parts to hand tools to fruitcakes and cocoa, is subjected to essentially the same regulatory framework as are major acquisition programs. This class of transaction therefore offers the greatest potential gains from tailored deregulation.

Standard Products. In buying generic or standard products, DoD will have abundant information about the product and prices paid, and a highly competitive market. DoD will need only to be sure that the product meets the promised standards. Today, such items can be purchased through catalogues using commercial practices. But when DoD seeks to purchase items requiring relatively minor modifications for defense use, the transaction may fall under the DoD regulatory umbrella. Laws and regulations that may be appropriate to unique technologically advanced systems developed on a cost reimbursement basis are being applied to systems that do not require such regulation.

b. Regulatory Goals and Tailored Deregulation

The coverage of DoD's regulatory umbrella has been extended to a wide range of transactions for which it is not appropriate. Important efficiency gains can be achieved without undermining taxpayer interests by tailoring the coverage. For many transactions there is a range of alternatives to regulation involving strategies to improve DoD's leverage in the contracting process by creating a more market-like environment. In each of the seven major categories of DoD regulation discussed below, we find there are potential gains from tailored deregulation (Table 3). These include both efficiency gains for ongoing business, as well as an increased potential for reconstitution.

Table 3. Tailored Regulation

Category of Regulation	Product Class			
	Major New Development	Modification, Component or Low Risk Development	Customized Version of Standard Product	Generic or Standard Product
Cost Accounting Standards	Apply	Tailor, Based on Degree of Cost Sharing	0 *	0
"How To Manage" Requirements	Apply	Tailor, Based on Degree of Cost Sharing	0	0
Technical Data Rights	Apply	Tailor, Based on Degree of Cost Sharing	0	0
Military Specifications	Apply, Where Technologies are Unique	Apply, Where Technologies are Unique	0	0
Unique Contracting Practices:				
Solicitation	0	0	0	0
Criminal Penalties				
Unique Social and Environmental Regulations	0	0	0	0

* 0 indicates: does not apply

Cost Accounting Standards. DoD regulations and cost accounting standards are meant to guarantee that the government pays a fair price. The use of detailed cost accounting rather than market research and other methods of estimating the fair price creates an illusion of accuracy and fairness in what are arbitrary rules and allocations. But cost accounting standards have hardly been a solution to the problem of guaranteeing a fair price. The burden may have shifted from the contracting officer to the auditors, but the basic uncertainty has not been reduced.

In many cases, existing regulations could be replaced with improved market analysis. Even custom made products, if they are variants of more commonly bought products, can be compared in terms of price and characteristics with more common items. For example, prices of rugged computers based on the IBM PC or Macintosh technology could be compared with their commercial counterparts. Such market analysis, combined where appropriate with statistical cost analysis, is used by appraisers, whether for estimating the value of a building, a business, a private home, or an art object. By shifting to market analysis, DoD could eliminate pricing and cost accounting requirements for a large range of transactions.

A related concern is the need to account fully for costs in contracts that involve cost sharing. The DoD has promulgated regulations that attempt to ensure that a contractor can not shift costs from commercial items or DoD fixed-priced items to DoD cost reimbursement contracts. The burden of such regulations and reporting systems fall on both the DoD and the contractor. Contractors must either operate separate commercial and defense divisions, or adopt an accounting system that permits him to spread the cost of the added overhead to his commercial operation.²³

"How To Manage" Requirements. Standards, such as the "Manufacturing Management Standard,"²⁴ have little to do with the functionality of the product or even its specifications, but rather are attempts to monitor the management techniques of government contractors. Moreover, they frequently are sufficiently detailed that a contracting firm cannot demonstrate that its conformance to the standard based on the existence of a

²³ One alternative, where high risks make cost-sharing unavoidable, is to establish a simplified prospective payment system for overhead payments. This would establish a standard overhead factor for various kinds of products, rather than attempting to measure actual costs for each supplier. Such an approach would provide fair payments on average, give contractors powerful incentives to reduce overhead costs and, most importantly, eliminate the need for detailed DoD-approved overhead accounting. Simplified accounting requirements will remove a significant barrier that commercial firms have faced in doing business with the DoD.

generally accepted program, e.g., the fact that it has a quality control program, or by the fact that it has delivered quality products without flaws. Such standards increase the reporting burden on the contractor, and provide a barrier to the entry of commercial firms into the defense market.

Technical Data Rights. Much of the technology-related regulation stems from incidents wherein the U.S. government has paid twice for technology, foreign governments have benefited from research paid for by the U.S. government, or contractors have commercialized technology that was paid for by the government. This has led to DoD requirements that technical data packages for jointly funded research be turned over to the DoD for use by others outside the government, and that the contractor account in great detail for who funded which parts of the research and technical data. This in turn requires detailed and often arbitrary cost accounting allocation for research and development, with some risk that commercial property will be claimed by the government.

Government policy in this area creates significant roadblocks to the participation of commercial firms when privately created technology is involved. DoD may limit the subsequent exploitation of the product, may make the firm pay the government a recoupment charge for using what the firm considers to be mostly its own information, or may force the firm to turn over trade secrets to a competitor. The firm may simply be concerned that the government will protect its information in an inadequate fashion.

Military Specifications. DoD can not economically support the profusion of unique parts that would result from allowing complete freedom of program managers and contractors to employ whatever parts or subsystems they desired. Military standards and specifications thus perform a needed function. However, DoD could increase the availability of suppliers and products by moving from specialized military standards to commercial or non-government standards wherever possible. This is an area where DoD has made a great deal of progress in recent years.

Commercial Buying Practices. Government procurement regulations establish a "right" for any potentially qualified bidder to bid on contracts, and creates an obligation on the DoD purchasing agent to ensure that all such potentially qualified bidders are aware of the interest of the DoD in the purchase. This is a right which has no analogy in the

²⁴ "Manufacturing Management Program," Military Standard MIL-STD-1528A (USAF), September 9, 1986.

private sector.²⁵ The taxpayer's interests — that a fair price be established — can be met through separate, less onerous regulations. Such regulations would require the DoD agent to perform a market analysis to ensure that there are sufficient qualified contractors for a competitive procurement. In this way, DoD could bring government procurement practices closer to commercial practices and make the government market more accessible to a wider range of firms.

A second needed step toward commercial practice is to decriminalize DoD procurement law. During the 1980s, there was increased use of criminal statutes to enforce the government interpretation of the contracting laws. Misstatements of fact, even those that seem innocent and result in no loss to the government, are being prosecuted as if there were criminal intent.²⁶ These may include activities over which the contractor has no direct control, and may even include activities in which the contractor has made the government better off by not following the rules to the letter, e.g., substituting a more reliable part than was promised.²⁷ Criminal penalties raise the risks of entering defense business, and thus add to the barriers to entry into defense markets.

Social and Environmental Regulations. Firms that are already required to obey laws and pursue programs involving social, environmental, and work place goals should not have to set up separate systems to adhere to different laws simply because they supply DoD. The government should standardize regulations to treat DoD contractors the same as other firms engaged in interstate commerce. Thus the array of programs and

²⁵ The law gives "all qualified vendors" an interest in the competition. It is this complication that allows any "interested party," i.e., any "actual or prospective offerer whose direct economic interest would be affected by the award of a contract or by the failure to award a contract," to question and to lodge formal protests during any part of the acquisition process.

²⁶ The fraud statute, 18 USC 1001, states that--

Whoever, in any matter within the jurisdiction of any department or agency of the United States knowingly and willfully falsifies, conceals or covers up by any trick, scheme, or device a material fact, or makes any false, fictitious or fraudulent statements or representations, or makes or uses any false writing or document knowing the same to contain any false, fictitious or fraudulent statement or entry, shall be fined not more than \$10,000 or imprisoned not more than five years or both.

Similar wording is contained in 18 USC 286-287 involving "false claims" against the United States government. Also relevant is 18 USC 371 covering "Conspiracy to commit offense or to defraud United States."

²⁷ See C. Stanley Dees, "The 'New Morality' Environments in Government Contracts," *National Contract Management Journal*, Winter 1987, pp. 1-14. Dees quotes as follows from the DoD Inspector General's "Indicators of Fraud in Department of Defense Procurement," "...even if the item is as good, there is harm to the integrity in the competitive acquisition system which is based on all competitors offering to furnish the item precisely described in the specifications."

regulations that apply to firms like General Electric or Boeing as commercial firms, should apply as well to DoD contractors.

3. Maintain a Robust Science and Technology Base

Creating the ability to field superior weapons from a flexible, integrated civilian-military technology base should be the heart of DoD's reconstitution strategy. To achieve a technological capability that can be scaled up to producing needed military systems, DoD's technology programs need to focus on increasing DoD's ability to tap the commercial supplier base when needed for reconstitution. DoD's strategy should serve both to increase the capability of next-generation weapons, and to use advances in manufacturing and design technology to increase the available pool of suppliers who could support reconstitution. This section focuses on science and technology; the next discusses issues associated with design, engineering, and production.

a. The Science and Technology Strategy

DoD investment policy for the science and technological base should reflect the changing security environment and continuing advances in design and manufacturing technologies. Prior to the demise of the U.S.S.R., the U.S. faced a military threat that had strategic reach to the continental United States. It therefore focused on (1) developing and fielding military capabilities that overcame the numerical advantages of the U.S.S.R., and (2) continually redefining the terms of the competition in the area of greatest leverage for the U.S. technology, attempting to maintain a U.S. lead in the international technology competition.²⁸ Now DoD must pursue a more balanced approach that incorporates affordability and flexibility along with technology leadership.

Specifically, we believe the R&D program needed to support reconstitution should strive for the following goals:

- *Affordable Performance.* Use technology to increase performance relative to costs. Design weapons and manufacturing processes for low-cost production, and for easy transition from design into production.
- *Defense-Civilian Integration.* Create flexible development and production systems, integrated with the commercial product development and production facilities of the country. Support dual-use technology development. Adapt

²⁸ See *Defense Science and Technology Strategy*, Director of Defense Research and Engineering, Department of Defense, July 1992, p.1-4, for brief discussion of "Cold War S&T Drivers."

advanced commercial technologies and processes (domestic or foreign) into military-specific applications.

The Science and Technology Strategy promulgated by the DDR&E recognizes the need to channel defense technology development away from that pursued during the Cold War to a new strategy that responds to a more uncertain, less well-defined threat, and one that does not entail "a large-scale struggle for national survival."²⁹ Both the Executive branch and the Congress are committed to a robust S&T program, planning for it to grow despite the overall cutbacks in the defense budget.³⁰

Two "thrusts" of the S&T program -- synthetic environments and technology for affordability -- directly support the goals of the reconstitution strategy. They focus on developing the kinds of design and manufacturing tools that will increase DoD's flexibility to rapidly field new weapons. Moreover, within each area, DoD will sponsor a range of Advanced Technology Demonstration (ATD) projects to prove out both product and manufacturing technologies. Before a technology development can move from the science and technology program to the acquisition process, its proponents must demonstrate that the technology being demonstrated is "ready and affordable, [that] manufacturing processes are available, and [that] operating concepts are understood."³¹ If DoD manages ATDs according to these criteria, it can reduce the time needed to incorporate new technologies into weapons programs. The strategy thus promises to provide a sound base of proven, producible technologies for reconstitution.

b. Dual-Use Technology

An emphasis on dual-use technologies for meeting military needs is another way to expand the available pool of defense suppliers. In 1990, the Carnegie Commission on Science, Technology, and the Government noted that DoD funding had dropped from half to one-third of all U.S. R&D spending in the United States, this change having taken place

²⁹ *Defense Science and Technology Strategy*, op. cit., p. I-6.

³⁰ The Defense Department has begun to implement a coordinated S&T strategy, which promises to provide a more coherent program. The Defense S&T community has identified seven technology "thrust" areas central to the creation of next-generation forces. These are global surveillance and communications, precision strike, air superiority and defense, sea control and undersea warfare, advanced land combat, synthetic environments (real and simulated environments for training and management), and technology for affordability. *Ibid.* p. I-18, and Section II.

³¹ Yockey, op. cit., pg. 3. Under Secretary Yockey notes that technology demonstrations are not new. What is new is the scope and depth now envisioned, their increased importance in the acquisition process, and the increased involvement of military users in guiding and evaluating the demonstrations. See *Defense Science and Technology Strategy*, op. cit., p. I-16.

even given the build up of the late 1970s and the 1980s. At the same time, it noted a rise in the importance of foreign technology. The Commission went on to suggest that, because of these two changes, "DoD needs to draw upon the much larger commercial technology base [and] the nation's economy ... needs to benefit from DoD's still large expenditures on technology." Hence, if DoD continues to rely on specialized technologies, it will restrict its access to some leading technologies, and greatly reduce the number of firms that can supply DoD's needs.

DoD science and technology policy and strategy do not yet explicitly reflect the need to integrate the defense and commercial supplier base. The two most recent documents that DoD has produced on S&T strategy, *The Defense Science and Technology Strategy* and *The DoD Key Technologies Plan*, focus narrowly on the national security aspects of technology development with little regard to integrating or relating this development to the activities or capabilities of the rest of the government or commercial industry.

A number of government and industry panels have shown a "...substantial overlap ... between those technologies essential for national security and those that contribute to economic competitiveness." The National Critical Technologies Panel further notes that —

Although a small number of highly defense-specific DoD Critical Technologies (e.g., signature control, pulsed power, and high energy density materials) are not included among the National Critical Technologies, most of the DoD technologies are "dual use" in nature, and potentially are as important for their non-defense applications as they are to DoD.³²

Thus, in the future the DoD should seek to coordinate and integrate its strategy and programs for technology development with those of other government departments and with commercial industry. In this manner, it could strive to achieve a balanced technology investment portfolio. At the same time, multiple-source funding is a strength in the U.S. system, and there should not be any attempt to impose a central control mechanism on technology base funding that allocates funds in detail.

4. Establish Flexible, Integrated Engineering and Production Capabilities

Reconstitution requires engineering teams experienced in designing, developing, and producing large, complex systems such as weapons systems. Such teams are

³² See Report of the National Critical Technologies Panel, (Washington, DC.: U.S. Government Printing Office, March, 1991), p. 4.

expensive and difficult to assemble and are difficult to hold together if they do not have serious work to do.

As defense procurement decreases, defense contractors will be forced to scale back their engineering work force, and will cut back production and seek more foreign business. Without special attention, therefore, greater integration of design and production may not occur. DoD needs to explore ways to ensure that designs can be moved into production. For example, can tanks be produced using available industrial capabilities such as heavy machinery, tractor, or truck production lines? Planners need to think about the design-development-production relationship in new ways, and the design process itself must be used to test methods of going from development to production.

It is not yet clear whether maintaining a core of design, development, and production engineering teams will be a problem and, if so, to what extent and in what areas. For example, in warfare areas such as tactical aircraft, where there are ongoing development programs, the needed cadre of aircraft engineers obviously will be retained. But over time, if the current developments are not produced as "fieldable" systems and if there are reduced efforts to design newer systems beyond those currently conceived, it is likely that these engineering teams will dissipate. A review of such problem areas is needed to identify alternative mechanisms for retaining or reconstituting key development and design capabilities.

a. Engineering Tools and Methods

Improvements in design and engineering tools need to be pursued to reduce the time needed to field the next generation of weapons. Computer-aided design (CAD) tools can reduce the man-hours required to design and engineer a product. Coupled with computer-integrated manufacturing (CIM), CAD tools can reduce substantially the time required to transition from design into production. In addition, techniques to flexibly integrate military production into ongoing civilian production are essential. The combination of these new technologies should broaden the potential supplier base, allowing defense production to be supported by computer-operated machine tools throughout the economy. For example, as part of the subcontractor-supplied technical data package for the Patriot, Raytheon required one of its subcontractors to provide an extra copy of the computer tapes used to drive the numerically controlled machine tools employed in making gyroscope components. Using these tapes, another supplier with similar machine tools could begin manufacturing these components very quickly. Thus, the extension of such technology could substantially increase DoD's flexibility to tap new suppliers when needed to support reconstitution.

Computer simulation can facilitate the flexible manufacturing of defense components and systems in an integrated production environment. The ability to simulate products and manufacturing processes in the design phase will in time allow designers to create "virtual prototypes." In this environment, new designs could be analyzed on a computer-simulated, virtual battlefield. Just as important, many of the technical and manufacturing problems that presently plague acquisition programs in the engineering and manufacturing development phase may be eliminated by utilizing these methods, allowing next-generation weapons to be fielded far more quickly than is possible today.

The tools described above should enable even greater use of "concurrent engineering" techniques (and similar new approaches to managing development programs) that can sharply reduce the time required to develop new systems. One aerospace manufacturer used concurrent engineering principles to reduce development time by 45 percent.³³ Automobile manufacturers that employ "lean design" principles are able to design a new model in about three-fourths the time — using about two-thirds the engineering hours — required for traditional design practices.³⁴ By adopting such approaches, manufacturers can reduce the time required to move next-generation weapons from the design stage through development and into production. Doing so would significantly contribute to meeting reconstitution objectives.

b. The Flexible Factory

As more firms adopt lean production and agile manufacturing, these techniques will make it increasingly feasible to integrate many kinds of defense production with commercial production. The goals of applying flexible manufacturing to defense include (1) the fabrication of rapid prototypes and the production of items in small lots for defense applications at unit costs approaching those of mass production; (2) the use of "programmable factories" driven by concurrent engineering concepts that have been optimized for zero-defects using "virtual factory" simulators; and (3) the integration of defense production with civilian-commercial production lines to achieve maximum return to

³³ Lew M. Job, "Concurrent Engineering: Case Study," General Dynamics Corp. Briefing, January 24, 1992.

³⁴ James P. Womack, Daniel T. Jones, and Daniel Roos, *The Machine that Changed the World*, (New York: Macmillan Publishing Co., 1990). As defined by Womack and his coauthors, lean design entails four basic principles: (i) Project leadership with control of project personnel, budgets, and schedules, (ii) Project teamwork involving a core of personnel working full time on the project, (iii) Project communication that includes clearly defined project performance metrics and milestone exit criteria, (iv) Simultaneous development that includes creation of production equipment in parallel with the product.

scale during peacetime operation and rapid transformation when needed for stepped-up military production.

DoD identifies flexible manufacturing as one of its 21 critical technology areas. The Department's recent Critical Technologies Plan notes that flexible manufacturing could "eliminate the need for a dedicated military facility, reduce component costs,... and avoid the necessity for building up inventory in anticipation of sourcing problems."³⁵ These new technologies will both improve productivity and help to integrate defense production within the broader civilian economy. Projects supporting flexible manufacturing include automating product data; computer-aided design, engineering, and manufacturing; data base management; communications; enterprise integration; and intelligent software. Research funding is projected to equal \$25 million in FY1992, rising gradually to \$31 million by 1997.

c. Information Systems

The DoD production process, with its linkages among prime contractors, multiple subcontractors, and vast numbers of suppliers, offers the prospect of achieving greatly increased efficiencies through the use of information processing and analysis technologies. Thus, enterprise integration will not only reduce costs, but also will enable peacetime industry to respond to greater national security demands.

d. Production Simulation

Manufacturers should experiment with new techniques and be able to develop expertise in them quickly. If systems are designed for such flexibility from the outset, then the transition difficulties should be lessened. But it will be necessary to ensure that the overall concept and capability for rapid conversion is in place. This is one of the great potential values of "virtual" factory simulation. Specifically, if factories and the information linkages among enterprises are developed using computer modeling techniques, and these techniques are able to update and evaluate production operation of individual enterprises and their interrelationships, then these simulations can be used to estimate defense production capabilities. The use of advanced simulation systems to design new, flexible production facilities and to evaluate their efficiency over time should provide much greater capabilities to plan and prepare for the contingencies of reconstitution, when required.

³⁵ DoD, "DoD Critical Technologies Plan," May 1991.

5. Summary

We have described how many of DoD's ongoing programs are contributing to reconstitution capabilities, and have in addition identified a range of relatively low-cost options for implementing a reconstitution capability. Within this framework, reconstitution requires preserving current-generation assets only in those cases where these assets are critical in laying a foundation for future design, engineering, or manufacturing capabilities. At the heart of the strategy are programs and policies that increase the nation's flexibility to expand military power using innovative force designs, new technologies, and advanced design and manufacturing tools and methods. By focusing on these, DoD can continue to develop the capabilities needed to ensure U.S. security beyond the turn of the century.

C. EVIDENCE OF POSSIBLE RECONSTITUTION DEFICIENCIES

A 1992 DoD policy white paper stated that, as the defense budget shrinks, the DoD must identify those products and processes that will be essential for modernizing or reconstituting forces.³⁶ In particular, the paper stated that DoD will need to take special actions in cases in which "there is no other solution on the horizon" for preserving "a unique capability [which otherwise] may be lost in a way that will likely preclude timely reconstitution." The initial question addressed in this section is whether objective criteria can be established to decide when special action is needed to avoid the emergence of such "lost arts." Two sets of evidence are then reviewed to determine the likely extent of deficiencies that may require special action.

1. Criteria for Identifying Deficiencies

Time is the key variable in assessing reconstitution capabilities. The question of primary concern is: If we had to expand supplier capabilities to expand forces beyond the turn of the century, could we do it quickly enough to reconstitute within 6 to 8 years? For certain highly complex capabilities and skills, it might be imperative that they be in place several years in advance of the 6 to 8 year time frame in order for production to occur. Thus, DoD should be legitimately concerned with capabilities that [1] are critical to future defense production, [2] could disappear with defense budget cutbacks, and [3] would take more than 3 to 5 years to reestablish. We have called those capabilities that could not be reestablished within this time frame "long-lead capabilities" (LLCs).

³⁶ Policy White Paper on Acquisition Strategy, Deputy Secretary of Defense Atwood, 1992.

In practice, these conditions dictate a stringent set of criteria for justifying intervention to preserve a capability. First, many of today's capabilities simply will not be critical in the future. Indeed, one of the objectives of DoD's reconstitution strategy, as discussed in Section B, should be to focus on eliminating areas where there are such unique defense-specific production requirements. Second, in most warfare areas, reduced defense budgets will not jeopardize defense production capabilities. Even with reduced budgets, DoD will still be spending \$90 billion or more per year on research, development, and procurement. A broad base of capabilities will be retained by this funding. As part of its new S&T strategy, the Department plans a broad range of ATD programs. Thirdly, the lead time to regenerate most capabilities will fall well within the limits established for reconstitution.

Three general criteria can be posited for identifying prospective production base deficiencies that might warrant special action. First, DoD must expect that a capability will be militarily significant for future reconstitution and determine that the capability is inadequately supported by ongoing DoD programs. Second, the capability must be unique to defense, and therefore not retained in the civilian sector. Third, there must be no alternative weapons or tactics that can fulfill the need. Fourth, the capability must be difficult and time-consuming to reestablish. In most cases, such highly specialized capabilities would be embodied either in highly specialized worker skills or in the group knowledge of design, engineering, or production teams.

We would suggest the following criteria for identifying such a highly specialized capability:

- *It is defense-specific and few people know how to do it today.* The capabilities that would likely need to be given special attention would be those that are not commonly used throughout commercial industry. If they were, the cutback in defense production would have little impact on the overall availability of these skills in the future for defense. Generally the skills likely to be of interest would be defense-specific and narrowly specialized. Examples are the welding of metal armor or the design of high performance aircraft.
- *The skill is perishable, and would take a long time to re-learn.* While skills that are hard to learn are not always equally hard to retain, there are concerns that there are some areas where arcane skills will atrophy. An often cited example is armor welding, since it requires extensive training and experience.
- *A high degree of teamwork is involved.* Teamwork takes time to establish, and in areas such as design where an effective team is essential, the recreation of teams that are disbanded in the drawdown could pose a serious impediment

to reconstitution. Design teams for aircraft or ships are prime examples. On the other hand, the engineering teams for programs such as Apollo or Polaris were geared up and operational fairly quickly, so the evidence on this issue is mixed.

- *The skills require special facilities and equipment that take time to reestablish.* If apart from the skills of the workers that must be geared up there is also a long lead time for procuring the facilities and equipment they will use, then additional bottlenecks are raised. This is why the reconstitution strategy emphasizes integrating defense with commercial industry.
- *Research and development cannot remove the need for the capability.* The reconstitution strategy emphasizes research aimed at reducing DoD's reliance on specialized capabilities. In many cases, new designs and technologies could eliminate the need for specialized skills or production facilities.

2. Defense Purchase Trends as Indicators

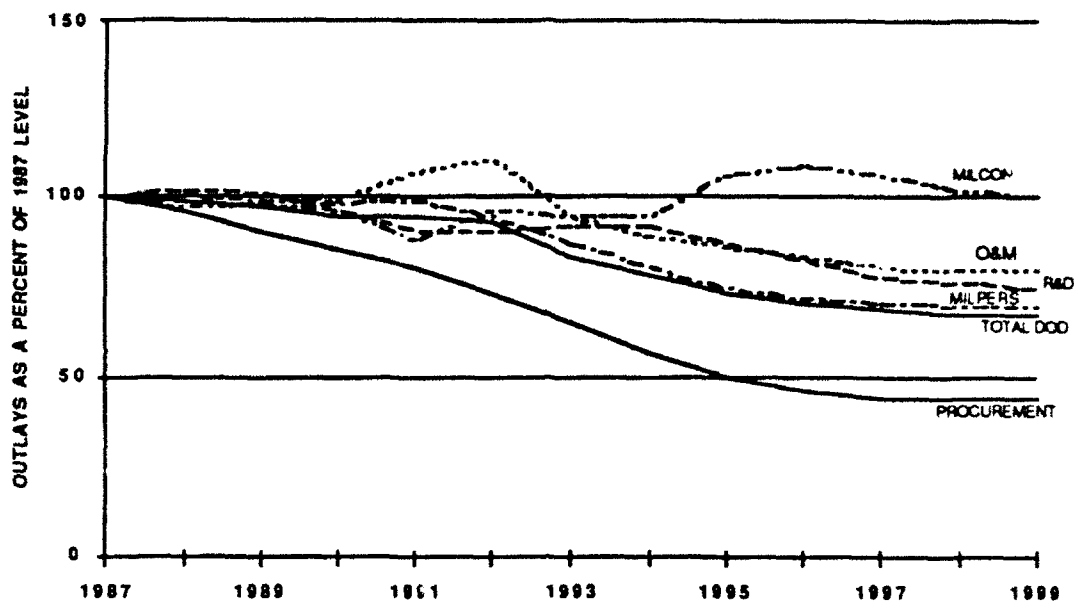
A first-order indicator of the effects of the defense drawdown can be obtained by using economic models to estimate how industry demands will change as defense purchases are cut. This kind of analysis helps to assess for each industry the degree of shrinkage or consolidation that may be induced by the drawdown. These broad trends provide a very crude screen for judging whether the impacts of the drawdown are so severe that industry's ability to support reconstitution is jeopardized.

Substantial demands on industry are generated by spending for operations and maintenance and research and development, as well as for procurement. It is therefore important to examine trends in each of these areas (Figure 1). By 1997, the defense drawdown will reduce total outlays about 30 percent relative to the peak levels of the late 1980s. Research and development and operations and maintenance spending will fall somewhat less than total spending; substantially more will be cut from procurement than any of the other major budget categories. By 1997, procurement outlays are projected to fall to under 50 percent of their 1987 level.

The implications of the budget cuts on broad industrial sectors is estimated using a methodology developed by the Department of Defense for assessing the effect of defense spending on the economy.³⁷ In this approach, defense outlays are allocated to those sectors from which DoD traditionally procures hardware or services. These allocations are

³⁷ The calculations presented are based on an adaptation of the Defense Department's Defense Economic Impact Modeling System (DEIMS). The DEIMS "translator," which allocates defense spending across industries, was used in conjunction with an input-output framework created for the Joint Industrial

Figure 1. Outlay Trend Estimates for Major Budget Categories (1987 = 100)

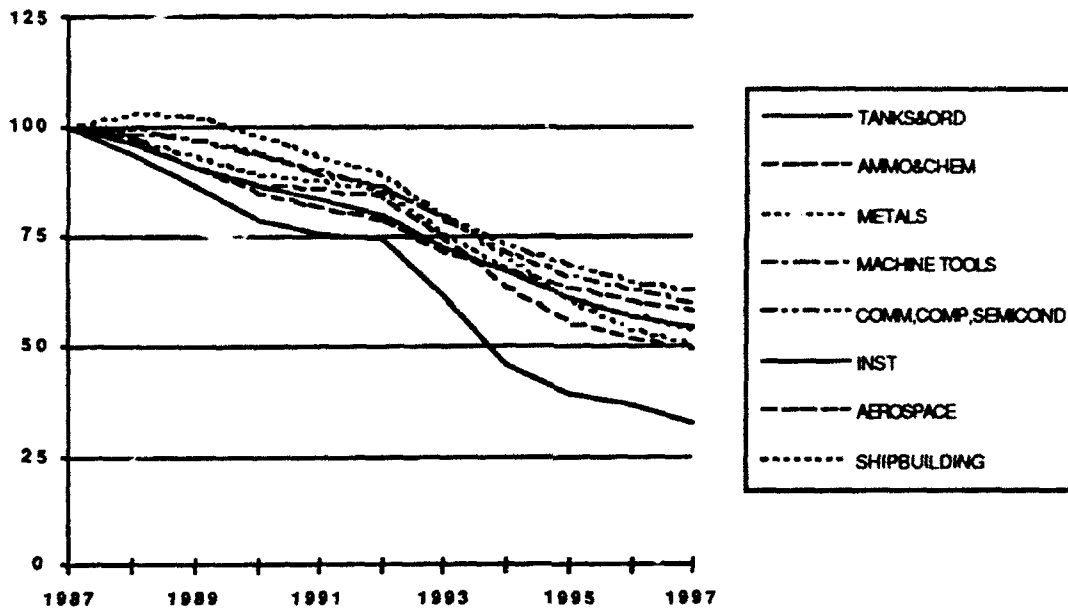


used within an input-output economic framework to estimate the indirect demands created by these direct purchases. For example, aircraft purchases would be allocated to the aircraft, engine, or communications industries, and the activity in these industries would create indirect demands for aluminum, semiconductors, or business services. The method thus shows how defense demands cascade downward through the economy, providing a comprehensive assessment of defense demands.

The trends in defense demands for a few major categories of supplier illustrate the overall pattern (Figure 2). The defense demands on each sector will fall to under 70 percent of its peak in the late 1980s. By far the most dramatic cuts come in the industries supporting ground combat (tanks and ordnance), where demand will fall to about one-third of its 1980s highs. Each of the other supplier groups also will experience substantial cuts in defense demands, with demand falling to between 50 percent and 65 percent of the peak levels of the 1980s.

Mobilization Planning Process. A cross check shows that the method employed provides estimates that are similar to the DEIMS, with an average difference for the top defense sectors of about 12 percent. We believe the approach used here provides a sound basis for analyzing trends in industrial demands associated with defense.

Figure 2. Trends in Defense Demands on Industry



The impact of these defense spending cuts on total industry demands will depend on the share to the industry's business accounted for by defense (Table 4). DoD accounts for virtually all of the demands in the tank and ordnance industries, because only a very small amount of such arms are sold "commercially" to foreign governments without DoD involvement as a middle man. Hence, a 67 percent cut in DoD business translates into an equal percentage cut in total industry business. In aerospace, shipbuilding, ammunition and chemicals, and communications, DoD business ranges between 40 and 60 percent of the industry demands. The projected defense cuts account for a smaller, but still substantial share of total industry business. The total cuts range from about 16 percent up to about 32 percent of total industry demands. Each of these industries is expected to experience a decline in defense demands that is substantial relative to the industry's overall business base.

In most other U.S. industries, DoD represents a small fraction of business, so even a relatively large percentage cut in DoD's demands will not substantially reduce total demands. Three of the sectors in our sample illustrate this relationship: metals, machine tools, and precision instruments. DoD accounts for about 9 percent of the demand for metals in the U.S., which means that a cut of 46 percent in DoD's demands still reduces total industry demand by only about 4 percent. For most industries, the effects will be

similar or smaller, so the overall health of the industry is not jeopardized by the planned defense cuts.

Table 4. Changes in Defense Relative to Total Industry Demands

Industry Group	Defense Demand Cut (%)	Defense Share of Group Total Demand (1991 Data)* (%)	Defense Cut as a Share of Total Industry Demand** (%)
Aerospace	41	52	21
Shipbuilding	50	50	25
Tanks & Ordnance	67	100	67
Ammunition & Chemicals	50	63	32
Comm., Comp. Eq. & Semiconductors	37	44	16
Metals	46	9	4
Machine Tools	40	7	3
Instruments	45	15	7

* Source: Logistics Management Institute, "Impacts of Defense Spending Cuts," October 20, 1992, pg. 12 and 13.

** Column 3 equals the product of columns 1 and 2.

These industry-level analyses support three conclusions. First, one sector — tanks and ordnance — faces major cuts that, on their face, could disrupt the industry sufficiently to jeopardize future reconstitution capabilities. Given the dramatic shrinkage required in this sector, it would be prudent to give it careful consideration as a source of possible deficiencies in future reconstitution capabilities. Second, another group of industries — shipbuilding, aerospace, and ammunition and chemicals, and communications, electronics, and semiconductors — will face cutbacks of 20 to 32 percent. Although their problems are not as deep as those in the ordnance sector, there will be substantial contraction and realignment required in those industries. The potential for transitional difficulties and deficiencies should be given careful consideration. In all other industrial groups, DoD is

not so prominent that the viability of the entire industry is jeopardized by the cuts. In sectors such as metals, machine tools and instruments, 93 percent or more of the total industry demand remains in place — even assuming no other sources of growth offset the defense cuts. Third, we can conclude therefore that any risks of deficiencies in most sectors result from DoD's reliance on specialized defense supplier niches within the sector. If DoD could break down the design and administrative barriers to defense-commercial integration, abundant capabilities would be available in most sectors.

3. Evidence From Sector Studies

To understand how specialized requirements affect the ability to reconstitute, we turn to the available studies of specific DoD production requirements to determine what lessons can be learned. To provide the DCC with the fullest possible basis for their evaluation, we compiled and reviewed every available study that has been performed by the Services or Defense Agencies in the last several years. In all, we reviewed 130 studies. They covered all of the major warfare areas, except strategic and nuclear systems. (Table 5 identifies the organizations that conducted or sponsored the studies and the sectors examined.)

Table 5. Sector Studies

Study Org.	Number Of Studies For Each Sector										Total Documents*
	Ship-bldg	Cmbt. Veh.	Air-Craft	Space	Elctr.-Comm.	Msls.	Ammo.	Cmbt. Spt.	Genl.	Not Classi-fied	
OSD	3	4	4	1	4	4	1	1	0	1	6
Army	0	5	3	1	5	3	3	4	0	0	16
Navy	18	0	2	1	5	1	0	1	1	3	25
Air Force	0	2	10	7	13	10	6	1	11	0	42
DLA	0	0	0	0	0	0	0	1	0	0	1
Other DoD	0	1	0	0	2	0	0	0	0	3	5
Other Govt.	1	0	1	1	2	2	1	0	10	2	14
Open Lit.	0	0	1	0	0	0	0	0	0	11	11
Non-Govt.	5	0	3	3	0	0	0	0	0	3	11
TOTAL	27	12	23	14	31	20	11	8	21	23	131

* This is the total number of documents. However, the sum of the sector entries may be greater than the number of individual documents because one document may include several sectors.

In examining these studies, we reviewed both the substance of the reported findings and the methods and approaches. Appendix C contains a bibliography of the documents reviewed, and Table C-1 provides summary data about each document. For several reasons we did not expect these studies to provide extensive evidence on reconstitution *per se*: The studies were done for a broad range of reasons; many predated the collapse of the USSR and the resulting changed defense environment; and they used an array of alternative approaches and assumptions. We nevertheless sought to determine whether they would indicate where long lead times might jeopardize reconstitution.

Some of these documents' findings have been used to suggest the need for "special action" in specific defense production areas. As we shall discuss below, the available evidence occasionally is stretched to make this case. In a few cases, the studies themselves identified capabilities they believed would not be adequate to support reconstitution (Table 6). Thus, if one were to undertake an in-depth study of possible resource base deficiencies, these areas would rank among the leading candidates for review. In addition to the capabilities found in the literature review, DoD currently is reviewing the submarine construction base, whose nuclear propulsion production capability is highly tailored to defense.

Table 6. Capabilities Cited as Requiring Intervention

System or Production Sector	Justification for Intervention
M-1 Tank	Key worker skills lost Tank armor production facility closed
Aircraft Carriers	Key Worker skills lost -- Second and Third Tier Vendors
Shipyards	Only one to two major yards will survive the drawdown
Aircraft Design	Needed skills will not be developed

To augment these sector studies, we conducted a review of the defense electronics sector. This sector is important for future warfare capabilities; it accounts for a sizable fraction of the spending for many programs, and yet is difficult to assess because most electronics purchases are embedded in major platforms such as aircraft or ships.³⁸ We found that the defense electronics sector will consolidate as the drawdown

³⁸ Steve Irwin, "The U.S. Defense Electronics Industrial Base: Outlook and Assessment," (Washington, D.C.: Defense Forecasts, Inc., November 25, 1992).

progresses, but that a broad supplier base will be retained. After 1995, the demand for defense electronics is projected to resume growth. Moreover, despite the downward trend in defense electronics purchases, the overall electronics sector has continued to grow at rates faster than the national average — between 1982 and 1990, U.S. factory sales of electronics grew at an annual rate of 13 percent. The continued growth in commercial demands thus have more than offset the decline in defense demands. We conclude, therefore, that DoD will continue to have access to adequate capabilities across the electronics sector. Any reconstitution deficiencies that might arise would not be due to the broad decline of the sector, but rather to problems in highly specialized niche markets.

We further conclude that few important capabilities will require intervention and that the ones that do will lie in the few highly specialized warfare areas where production will cease. This conclusion contradicts some of the studies we reviewed. In many cases, researchers hinted that some form of intervention was needed. There are three reasons why our conclusions differ. First, some studies simply addressed different questions; few focused on reconstitution as we define it. Second, many used a range of different assumptions about scenarios and time frames. Third, the studies often relied on indirect indicators of possible problems rather than probing thoroughly to demonstrate that a problem would in fact occur. These issues are central to understanding the message of this overall body of literature and are therefore discussed in some depth below.

a. Questions Addressed

Most of the literature we examined tried to answer questions that differ from those raised by the reconstitution issue. They focus on questions such as the following:

To what extent can the existing industrial base "surge" production meet military demands in the event of a national emergency? Traditional industrial preparedness activities have focussed on surge and mobilization for supporting (and quickly expanding) standing forces. Industrial base studies naturally focused on this problem during the Cold War. This was an important issue in its time, and continues to be important for items needed to support the deployment of existing forces in crisis response scenarios. But answers to it are not relevant for reconstitution, since the time frames for reconstitution are much longer than the planning assumptions used in surge and mobilization assessments.

What firms may stop being DoD suppliers as production budgets are cut? Knowing the answer to this question, even in considerable detail, does not help to define the extent of possible deficiencies. Clearly, many firms will stop supplying DoD, and some may go out of business altogether. It does not follow that we should focus special actions on these

firms or some subset of them. It may be that production capacity in the defense industry will remain adequate, or that commercial production can be substituted, particularly if greater integration with commercial industry is achieved.

What is the extent of foreign dependence in current production practices, or to what degree will "foreign intrusion" increase in the absence of some special action? Here again, answers to these questions are of limited value in defining the extent of reconstitution deficiencies. Dependence on overseas suppliers does not necessarily imply dangerous vulnerability to supply disruptions. Moreover, most dependence studies do not show that domestic production is unachievable, only that foreign sourcing takes place. Also, remedies to dependency, even when it is extreme, can be developed in advance; they can be designed around, or production arrangements can be made in advance. Where specific dependencies that can limit future defense production are identified, policy measures for remedying them are justifiable. Dependence on an overseas supplier might constitute dangerous vulnerability to supply disruption if (1) the United States would have considerable difficulty producing timely substitutes of acceptable quality; (2) overseas suppliers were concentrated, making cutoffs more plausible; and (3) substitutes were hard to stockpile. So far, few such dependencies have been identified.³⁹

Where do we rely on sole suppliers now and where are we likely to do so as a result of impending spending cuts? Answers to this question would help bound the extent of reconstitution deficiencies if DoD could assume that sole suppliers are necessarily critical suppliers. When DoD recognizes multiple producers of an item but only buys that item from one, it refers to that producer as a "single source." When it recognizes and buys from only one producer, it refers to that producer as a "sole source." Will we be able to reconstitute in a timely manner without special action on behalf of sole sources? This depends on how quickly other potential suppliers could produce acceptable substitutes for whatever the sole source makes. Judgments on this issue in turn depend on the technical

³⁹ Theodore Moran argues that in some cases, dependence on overseas suppliers can limit a nation's freedom of action in international affairs and thereby diminish its security. On the other hand, he says across the board efforts to eliminate dependence can also threaten national security. Moran argues that the U.S. should feel free to purchase goods abroad where there is a wide range of potential suppliers, because such diversity would limit the nation's exposure to embargoes. See Theodore Moran, "The Globalization of America's Defense Industries: Managing the Threat of Foreign Dependence," *International Security*, Summer 1990.

Additional attempts to assess foreign sourcing can be found in Erland Heginbotham, et al., *Dependence of U.S. Defense Systems on Foreign Technologies*, IDA P-2326, Institute for Defense Analyses, Alexandria, VA., December 1990; Richard Van Atta, et al., *Technical Assessment of U.S. Electronics Dependency*, IDA P-1841, Institute for Defense Analyses, Alexandria, VA, November 1985.

problems associated with making the item in question, and the capacity of firms to do so. Most studies that discuss the "sole source" problem do not explicitly provide such information. Without this additional information, sole source status alone would not justify special action.

b. Time Horizons and Planning Scenarios Considered

Most of the documents we reviewed did not explicitly state the kinds of timing assumptions that underlay their arguments. For example, some appeared to assume that, without special action, workers would lose the skills that they now use to produce systems for DoD. The longer the time before reconstitution, the more plausible this assumption. However, one cannot decide which skills are most perishable (and, other things equal, most deserving of special action) unless production experts provide estimates concerning:

- how quickly workers will lose skills, and
- how long it will take returning workers to re-learn them.

Other studies were explicit about timing assumptions and planning scenarios. For example, one set of studies explicitly assumed that the United States would be engaged in two Desert Storm-sized "major regional contingencies" in the FY95-96 period. Such explicit treatment of this critical factor helps one interpret study findings. Many others focused on production issues over the periods for which DoD typically plans systems acquisition. For the most part, therefore, the time horizons of the studies we reviewed did not extend past the end of this decade.

c. Indicators of Deficiencies

Some of the assessments we reviewed make arguments for intervention that, in our view, fail to provide sufficient rationale for special action. These studies often base their conclusions on indirect indicators that there may be reconstitution deficiencies. We present some of the common examples below because undoubtedly they will be raised in future discussions of conversion assistance.

If Firms Stop Production, Workers Will Not Return. Documents we reviewed frequently remark that, in the absence of special action, workers currently engaged in production will move to other firms and other jobs. This is clearly true — many workers will leave the defense industry and even the region where they had worked for DoD. There is every reason to believe, however, that offers of high wages would induce them to return to work if the nation needed them again. Most importantly, the reconstitution time frame will allow new workers to be trained to perform all but the most highly specialized tasks.

In addition, changes in production technologies will often tend to reduce the need for highly specialized workers. For example, advances in robotics could substitute for the highly skilled welders used in many current programs. (For workers with rare skills, DoD may wish to tie near-term transitional assistance with the condition that the worker register his or her address with DoD for a number of years.)

If Firms Stop Production, Workers' Skills Will Wither. As noted above, some skills are more perishable than are others. The critical issue for action is to decide which skills would take so long to re-learn (or to teach to new workers) as to make timely reconstitution difficult. Generally, the documents we reviewed did not provide evidence about how difficult it would be to retrain workers or for workers to resume performing their former tasks after a prolonged break. Nor did they consider the likelihood that workers released from defense work would find new jobs drawing on similar skills, and thus would retain "learning by doing" knowledge from working on commercial products.

Militarily Unique Items Will Likely Prove Difficult for a Commercial Industrial Base to Produce. This assumption is clearly true in some cases. However, the commercial industrial base can produce some systems for which there is no commercial equivalent or even near-equivalent. Consider the M1 tank, for example. This system has no commercial counterpart. Even so, detailed studies of the M1 have shown that our existing commercial industrial base can produce most of what's needed to produce an M1.⁴⁰ Thus, the fact that a system is militarily unique does not in itself constitute grounds for special action.

Today's Critical Production Capabilities Will Remain Critical Tomorrow. Analyses of the current production base inevitably focus on the ability to make the kinds of systems that DoD is acquiring today. To the extent that those analyses argue for special action to

⁴⁰ A 1986 IDA study estimated "expansion factors" for 12 key industries that contribute to M1 manufacture, assuming a national emergency with priority given to military production. The study argued that commercial firms in all but one of these industries could achieve a 3- to 24-fold increase in the output. It also stated that "it would be possible to adapt commercial facilities to perform tank fabrication and assembly within six months following the declaration of an emergency...."

The study found that "most of the structural components could be machined in commercial facilities, and most of the machines used in the tank plants exist in large quantities in other sectors of the economy." However, it noted that "the hull and turret machining operations ... are significant roadblocks to expanding tank production ... within the existing supplier base ... [and] ... would be the most difficult to accomplish using commercial facilities." They suggested, as a long-term solution, that "producibility should be given top priority in the early stages of design in all new systems ... [making possible] ... a new generation of vehicles that could be more readily produced in an emergency than the current generation of vehicles...."

See Richard T. Cheslow, et al., *Mobilization Capability for the M1 Abrams Tank and the Bradley Fighting Vehicle*, IDA Paper P-1992, Institute for Defense Analyses, Alexandria, VA, December 1986, pp. ES-vi - ES-ix.

retain current capabilities, they presume that these capabilities will be needed for tomorrow's weapons as well. But this presumption should be given careful scrutiny. Weapons technologies are changing rapidly, and the materials, skill requirements, and manufacturing processes change accordingly. For example, the tank production process changed greatly in moving from the cast turrets and hulls used in the M60 model to the welded structures used in the M1 Abrams. Stealth technology and new materials will change the processes for future weapons as well. In addition, advances in design and manufacturing processes will alter the desired means for producing future weapons. In short, the unquestioned use of today's production processes as a proxy for the processes needed tomorrow runs the risk of preserving capabilities that will not be needed.

4. Conclusion

The industry trend analyses and the sector studies identify certain areas where reconstitution deficiencies are most likely to appear, but neither demonstrates the need for special action to preserve specific capabilities. We conclude that the emergence of "lost arts" as a result of the drawdown will be rare. Even so, the sector studies we have reviewed present data that often are meant to support special actions to preserve particular pieces of the defense technology and production base. We find, however, that the conclusions of such studies frequently rest on implicit (and occasionally explicit) assumptions that are too broad or incomplete to guide policy choices. A more objective basis for such assessments is provided by a screening framework such as outlined in the beginning of this section. Proponents of special action need to provide more systematic evidence of potential deficiencies before DoD can properly decide how best to allocate the scarce resources available for preserving reconstitution capabilities.

D. ALTERNATIVE MECHANISMS FOR RETAINING CAPABILITIES

If further study identifies some capabilities that are potential "lost arts," what actions are available and appropriate to preserve them? This question raises three others: (a) What existing mechanisms are available for intervening to preserve a capability? (b) Are additional mechanisms needed? and (c) In particular, is conversion assistance a feasible mechanism for preserving potential lost arts? We describe two broad classes of potential mechanisms — programs for retaining production capabilities, and programs for retaining design and engineering capabilities.

1. Production Capabilities

Funds to improve or retain industrial capabilities come primarily from contractors' investments in their plant and equipment, but a limited amount is also available through a set of targeted investment programs. Through a combination of these mechanisms, DoD has substantial leverage to retain whatever production capabilities it deems necessary.

a. Contractors' Investments

Most of the defense production base comprises commercial suppliers working under contract to the government. The large capital infrastructure developed by these producers reflects investments they have made over the years to meet the terms of their R&D and production contracts. One study of aerospace contractors found that they invest approximately three percent of annual revenues in new plant and equipment.⁴¹ Given that DoD's spending for production and research and development will remain over \$90 billion in the foreseeable future, this percentage implies investments of approximately \$2.7 billion per year. Contractors will, of course, continue their investments in warfare areas where their current and expected future business provides appropriate profit incentives. In addition to these capital investments, contractors invest roughly \$7 billion per year in self-initiated research, which is partly covered in DoD's overhead payments.⁴² This allows them to fund a wide range of activities supporting future defense capabilities.⁴³ DoD contracts will thus provide ample sources of new investment funding in the broad range of areas where programs will continue.

But, does DoD have adequate leverage to influence critical sub-tier suppliers? Such suppliers typically contract with prime contractors to support the production of new weapons, so the government has no direct production contracts with them. The Services' logistics branches or DLA often contract with lower-tier suppliers to supply spare parts, which provides a mechanism for supporting them. Over the years DoD has often used

⁴¹ An IDA study of aerospace contractors found they invested about 3 percent of annual revenues in their productive capital, and that their net book value of capital equalled about 18 percent of annual sales. James McCullough and Steven Balut, "Trends in a Sample of Defense Aircraft Contractors' Costs," IDA D-764, Institute for Defense Analyses, Alexandria, VA, August 1990.

⁴² Department of Defense, *Defense Science and Technology Strategy*, July 1992, p. 1-2.

⁴³ The FY 1982 Defense Authorization Act stipulates a wide range of activities that may be funded under the Internal Research and Development and Bid and Proposal overhead account. These include; enabling superior performance of future U.S. weapons, reducing costs, strengthening the defense industrial base, enhancing U.S. industrial competitiveness, promoting dual use technologies, and improving environmental quality.

DLA contracts to maintain critical suppliers. One noteworthy recent example involves the sole domestic supplier of rayon.⁴⁴

Two additional contractual mechanisms for retaining defense capabilities are available. First, the planned producer agreement provides contingency contracts for emergency levels of production. A planned producer includes any government or private producer with a signed planned producer agreement or a surge option clause in its production contract. There are three kinds of planned producer agreements (see Appendix B): Memorandum of Understanding (MOU), No Direct Cost Contract, and Limited Fee Contract. In 1989 there were over 9,300 planned producers.

Second, the Special Defense Acquisition Fund pays for production in anticipation of foreign sales. This is a revolving fund to finance the acquisition of defense articles and services in anticipation of their transfer to eligible foreign nations.⁴⁵ This fund has been used to bridge the gap in production of some systems between the end of U.S. buys and the start of foreign buys. Funding for this program in FY1991 was \$350 million.

b. DoD Direct Investment Programs

Seven Industrial Base Program (IBP) funding programs explicitly target industrial base activities. These programs already support the maintenance of needed capabilities, or could do so with minor modifications. In FY1992 they received funding of just under \$1 billion (Table 7).

IBP programs fall into three categories. The first provides funding or contract incentives for DoD's private sector contractors. If reconstitution requires investing additional funds for contractor manufacturing process improvements, Title III, MANTECH, or IMIP funds can foster such investment.⁴⁶ The second category supports DoD-owned facilities or equipment, or raw material stockpiles. If reconstitution requires maintaining government owned production facilities, such as ammunition plants, the funding would come under these programs. The third includes funding to support industrial base planning and analysis.

⁴⁴ Interview with Defense Logistics Agency Production Division personnel.

⁴⁵ *Management of Security Assistance, Defense Institute of Security Assistance Management (DISM) Manual*, 11th edition, 1991 p. 45.

⁴⁶ It should be noted that each of these programs is in flux. MANTECH is being shifted from an acquisition to a research function, IMIP is being terminated, and the Title III program is being expanded.

Table 7. Industrial Base Program (IBP) Funding for FY 1992

(\$ Millions)

IBP Funding Category	Organization					Total
	Army	Air Force	Navy	DLA	OSD	
I. Contractor Investment Programs						
MANTECH	27.9	60.5 ^a	74.0	16.9	—	179.3
IMIP	11.2	3.6	—	— ^b	—	14.8
IPMs	0.4	—	—	2.5	—	2.9
Title III	—	0.6 ^c	—	—	—	0.6
II. Investment Programs for Government Facilities and Stockpiles						
Industrial Facilities	344.3 ^d	26.1 ^e	273.1 ^f	32.3 ^g	—	675.8
NDS	—	—	—	—	42.0 ^h	42.0
III. Industrial Preparedness Planning (IPP)						
IPP	2.0	0.3	3.5	2.5	—	8.3
TOTAL	385.8	91.1	350.6	54.2	42.0	923.7

^a Includes \$36 M of Congressional directed activities, not contained in the Air Force request.

^b Plant Equipment Packages for the Production of Tray Packs.

^c No Title III projects funds appropriated. Represents only Operations and Maintenance (O&M) to support Defense Production Act Title III Program Office.

^d Includes \$194.0 M for new equipment and active facilities, \$46.6 M for layaway, \$74.7 M for inactive facilities, and \$29.0 M for conventional ammunition demilitarization.

^e Includes Capital Rehabilitation, Environment Compliance, and O&M.

^f Sum of \$221.6 M for MILCON at industrial activities and \$51.5 M for Underutilized Plant Capacity (UPC) at Weapons Stations and Shipyards.

^g Industrial Plant Equipment

^h This is the sum of \$31.0 M for O&M and around \$11.0 M net for NDS acquisition impact (budget less actual disposal).

The Manufacturing Technology Program. With funding of approximately \$180 million in FY1992, MANTECH is far and away the largest of the Category I programs. Typically about 200 programs are funded each year, most of which are performed by industry. Accomplishments include the first numerically controlled machine tool, integrated circuit components, night vision devices, composite applications in nose cones and rocket nozzles. Recently MANTECH was transferred from a procurement function to a research function. This may increase its applicability as a potential mechanism for supporting long-range reconstitution capabilities.

The Industrial Modernization Incentives Program. IMIP was established in the early 1980s, after initial successful implementation in the Air Force. IMIP provided "funding specifically designated for offering incentives to industry for improving

productivity in all direct and indirect cost areas of the production process." Some of the projects included circuit board inspections, paperless planning, automated fault diagnostics, and advanced robotics. It appears that the IMIP program is being terminated; thus, it will not serve as a mechanism for maintaining needed capabilities.

Defense Production Act (DPA) Title III Purchases Program. The Defense Production Act of 1950⁴⁷ established the Title III purchases program, the purpose of which is —

... to establish or expand domestic production capacity for materials that are critical to the Department of Defense (DoD). Title III accomplishes this by providing domestic industry with incentives which take the form of purchases and purchase commitments for materials.⁴⁸

This program is explicitly designed to develop and maintain industrial capabilities for specialized materials, and thus provides a potentially useful mechanism for retaining the foundation for reconstitution in these areas. Some recent Title III programs include high quality quartz yarn, single crystal silicon, traveling wave tubes, and ceramic bearings. Such purchases could be directed toward maintaining specialized suppliers for the sake of reconstitution.

Industrial Preparedness Measures. DoD created the Industrial Preparedness Measures (IPM) program to fund the development or maintenance of industrial surge capability. This is the only DoD program that provides funding for direct investments in surge or mobilization capability. The best known examples of IPM investment programs are the procurement of rolling inventory for the TOW missile and a Navy sonobouy. Both of these programs were funded in the mid-1980s out of a \$100 million "surge wedge" program. The intention of this program was to identify and fund high-priority surge projects each year, gradually developing a broader capability for surge. This program has been curtailed, however, and currently only about \$5 million is being spent by the Army and DLA on industrial preparedness measures. An example of a recent Army program is the purchase of rolling inventories for the Avenger missile system.

Industrial Facilities. Industrial Facilities programs include funding to design, acquire, and construct new facilities and to expand, layaway, replace and modernize government-owned industrial facilities. DoD budgeted about \$675 million for these programs in 1992, making them the largest of its industrial base programs. The

⁴⁷ Sections 2061 to 2170 of Title 50 Appendix, United States Code.

⁴⁸ DoD, *The Defense Production Act Title III Program*, undated, p. 1.

government-owned arsenals have long provided important mechanisms for maintaining highly specialized defense production capabilities, such as nuclear warhead, ammunition, and high-explosives production. Although government ownership is not always desirable, it must be acknowledged that the arsenal system provides an effective mechanism to preserve whatever specialized capabilities are needed.

In addition to managing active facilities, the government also has an extensive program for laying away production equipment for future use. Layaways primarily are limited to ammunition production facilities and equipment. The Army has some experience in reactivating layed-away equipment for the M16 Rifle Bolt production line. Conclusions presented about this partial reactivation include:

... Rock Island Arsenal overcame above average problems during the production start-up phase, and through the use of the PEP-669 equipment, was able to reactivate a production line in 6 months with first full scale production delivery occurring in the 7th to 8th month. This represented a 7 to 9 month savings over normal contracting lead time.⁴⁹

In summary, government-owned facilities provide an important foundation for reconstitution in important defense sectors. As the defense budget is reduced, DoD will face important decisions regarding the role of industrial funded facilities relative to private contractors. Certain defense-specialized facilities that have resided mainly in the private sector, such as certain shipyards or aircraft plants, might best be preserved simply through government purchase. On the other hand, it has been suggested that a larger share of maintenance and overhaul work should move to commercial suppliers to keep the production-oriented supplier base in operation, while shrinking the base of government operated maintenance facilities.⁵⁰

National Defense Stockpile. The national stockpile now comprises several dozen materials with a total market value of \$9.1 billion. Goals for the stockpile are presently under revision. The DoD recently proposed the sale of a number of surplus materials and the purchase of high-technology materials. These proposed transactions would save \$2.9 billion. In theory, the stockpile provides a useful mechanism for preparedness planning, but in practice its flexibility has been limited by political pressures.

⁴⁹ U.S. Army Armaments, Munitions, and Chemical Command, "Partial Reactivation of PEP-669 at Rock Island Arsenal for M16 Rifle Bolt Production," April 1986, pg 11.

⁵⁰ The arsenal and private sector ownership approach, and how its applicability varies across defense sectors, is presented in OTA's *Redesigning Defense*, op. cit., Chapter 5. A discussion of maintenance base alternatives is presented in OTA's *Building Future Security*, op. cit., Chapter 5.

One question is whether political inertia will prevent any needed changes in the composition of the stockpile to reflect reconstitution requirements.

Industrial Preparedness Planning (IPP). The final category of the industrial base program, industrial preparedness planning, includes funding for industrial base plans and management activities aimed to prepare for emergency production. IPP funding includes the costs of special studies, data base development, data collection processes, and certain manpower costs. This small program should continue, and perhaps be slightly expanded to fund needed reconstitution planning and analyses.

c. Conclusions

Existing industrial programs provide an adequate programmatic framework to facilitate the investments DoD needs to retain industrial base capabilities for reconstitution. DoD of course has direct control over the facilities and equipment it owns. There also are a number of mechanisms for retaining the capital of private contractors. For prime contractors, this could be accomplished through procurement contracts, planned producer agreements, Title III purchases, or the industrial preparedness measures program. For the suppliers of components and spare parts, ongoing DLA or Service procurements for maintaining existing systems provide one mechanism for retaining a minimal level of production. Title III purchases or planned producer agreements could be used as well. The National Defense Stockpile already provides a mechanism for inventorying critical raw materials. (If need be, it could be expanded to include certain basic manufactured items.) In sum, the mechanisms exist for shaping the defense supply base to preserve essential production capabilities for reconstitution.

2. Design and Engineering Capabilities

The new S&T strategy emphasizes capabilities that can be proven with an Advanced Technology Demonstration (ATD). Within the science and technology community, capabilities must be proven before a technology will be cleared for use in an acquisition program. The intention is to ensure that the technology is ready, manufacturing processes are available, and operating concepts are understood before a formal acquisition program is undertaken.

DoD plans to maintain an active program of Advanced Technology Demonstrations across all of the key science and technology areas (Table 8). It could complement this ongoing set of programs, as needed, with ATDs that would address possible "lost arts."

Table 8. Top-Level Demonstration for the Seven Science and Technology (S&T) Thrust Areas

S&T Thrust Area	Top-Level Demonstrations
Global Surveillance & Communications	Flexible Architectures/Simulation Sensors Communications, Computing, and Databases Vehicles Technology Demonstrations (Other)
Precision Strike	Joint Air/Land/Sea Precision Strike Demonstration Warbreaker Technologies Artemis
Air Superiority and Defense	Tactical Ballistic Missile Defense Counterstealth Short-Range Air Defense Air Superiority Netted Systems
Sea Control and Undersea Superiority	Shallow Water Undersea Warfare/Conflict Platform Protection/Point Defense Tactical Multipliers
Advanced Land Combat	Advanced Vehicle Technologies (All Weight Classes) Rapid Force Protection Initiative
Synthetic Environments	Synthetic/Electronic Battlefield Acquisition Training and Readiness
Technology for Affordability	Flexible Microelectronics Manufacturing Pilot Flexible Factories for Signal Processors, Infrared (IR) Focal Plane Arrays Pilot Flexible Factories, for Affordable Radar Arrays, Gyros, Guidance and Control, Advanced Materials Infrastructure for Affordability

Source: *Defense Science and Technology Strategy*, Top-Level Demonstration Charts.

The ATD could thus provide the needed mechanism for maintaining progress within a warfare area without necessarily initiating a new acquisition program. For example, an ATD could be initiated to explore next-generation armor concepts, to fill the gap between generations of tank procurement. Similarly, an ATD on nuclear propulsion would maintain a capability even if current-generation nuclear submarine programs were ended. The judicious use of ATDs could thus provide an effective way to retain a broad base of capabilities. As noted earlier, ATDs must focus effectively on manufacturing considerations in each weapon area in order to fully meet reconstitution needs and must focus on new concepts in manufacturing.

3. Conversion Assistance

Defense conversion entails the redirection of all or part of a defense supplier's capacity to commercial production. Conversion raises many of the same issues as

presented in our earlier discussion of integration, which considered how to make it easier for commercial firms to serve defense markets. Both involve removing barriers to using a given production facility to supply both defense and commercial markets. As with integration, there are two potential barriers to conversion. The first consists of the physical differences between defense and commercial products and production processes. The second consists of the administrative and regulatory burdens placed on defense suppliers that render their operations uncompetitive in commercial markets. The reconstitution policies we outlined in Section B to break down the procedural and technical barriers to integration also apply to defense conversion. Thus the reconstitution strategy is also an effective conversion strategy.

Financial inducements to conversion also have been considered to supplement these policies to reduce technical and administrative barriers. For example, contractors are now permitted to spend overhead funds to explore commercial applications under the DoD independent research and development policy. Consideration also has been given to allowing contractors to defer allocating overhead costs to newly initiated commercial projects, and to liberalize DoD's recoupment policies to give contractors greater incentives to exploit DoD-related technology in commercial markets.

Such financial incentives may provide the needed financial margin for a successful conversion for those firms that can redirect their DoD products and processes to commercial markets. Companies in dual-use sectors, such as electronics or aviation, in many cases may be well positioned to enter commercial markets. However, it is unlikely that such programs will substantially improve the prospects of a successful conversion for specialized defense suppliers, such as those in nuclear weapons and production, combat vehicles, or ammunition. They are so highly specialized that they cannot easily be converted from defense to civilian uses and then back again. Their products and processes are simply too different to be applied to commercial use without fundamental restructuring, which would require subsidies comparable to the costs of starting a new enterprise. If DoD's demands fail to sustain such firms, the traditional course of action would be for them to disband and liquidate their assets. In this sense, these companies would still "convert" to civilian production, but through the dispersal and reemployment of individual pieces of equipment and through the release and reemployment of individual workers.

Conversion to commercial markets therefore is not a feasible solution for retaining essential reconstitution capabilities for specialized defense suppliers. The appropriate mechanisms for retaining these capabilities are those that keep them within the DoD sphere. These would include targeting the industrial base investment programs outlined here to

retain the capability, or commissioning an ATD in the warfare area to engage a design and engineering team. Funding for conversion may help to permit certain firms to establish new lines of commercial business similar to their defense business, but conversion funding is not appropriate for retaining potential "lost arts."

E. SUMMARY AND CONCLUSIONS

The four elements of the National Military Strategy are nuclear deterrence, forward presence, crisis response, and reconstitution. The first three elements are designed to meet the challenges of the existing global security environment. Reconstitution, in contrast, is a long-term strategy to ensure that the United States could expand forces quickly enough to respond to the emergence of as yet unforeseen threats.

The ability to reconstitute will depend upon the kinds of forces that will be created, available national assets, and the priority given to reconstitution. Most of DoD's ongoing programs for research and development and force modernization support reconstitution in one way or another. An appropriate reconstitution strategy would use ongoing programs to maintain the essential elements of the science, technology, design, engineering, and production base. It would focus on creating the flexibility to make the most of these assets in the event that the nation's forces had to be reconstituted. Creating this flexibility requires fundamental changes in the way DoD designs forces and develops and buys weapons. These changes will require sustained effort, but the effort will provide substantial returns, both in terms of the contribution to reconstitution capabilities and in improving peacetime efficiency and increasing DoD's access to leading commercial technologies.

The reconstitution strategy — coupled with advances in technologies, and design and manufacturing processes — emphasizes the importance of focusing on future supplier-base capabilities. It cautions against the temptation to preserve, without question, the production capabilities for current generation weapons. Our review of the defense production base suggests some areas where reconstitution deficiencies may be of concern, but available studies do not provide the evidence needed to justify special action.

We believe reconstitution concerns will require special action only in rare cases. There are two reasons why: First, DoD will continue spending \$90 billion or more on research and development and acquisition for the foreseeable future, and extensive design, engineering, and manufacturing capabilities will be retained through the ongoing programs supported by this funding. Supported by this funding, DoD's planned Advanced Technology Demonstration programs promise to provide a solid base of design and

engineering capabilities across a broad range of the most important warfare areas. Second, the 6- to 8-year build-up time available for reconstitution allows several years to reestablish needed capabilities, even if ongoing programs or special actions do not maintain an active supplier base. Our proposed criteria for justifying special action are thus quite stringent.

We conclude that the defense drawdown will not broadly undermine the ability of the defense resource base to support DoD's missions. The base will shrink, but a broad range of capabilities will nonetheless be sustained by DoD's ongoing programs. There is no hard evidence as yet of losses in capabilities that could not be restored as needed for reconstitution. We also find that, if appropriately funded and targeted, there already exist suitable programmatic mechanisms for retaining any design, engineering, or production capabilities that threaten to become "lost arts." Conversion assistance programs are not relevant for preserving "lost arts," because they are, by definition, highly defense-specialized capabilities that could not readily be applied to commercial uses.